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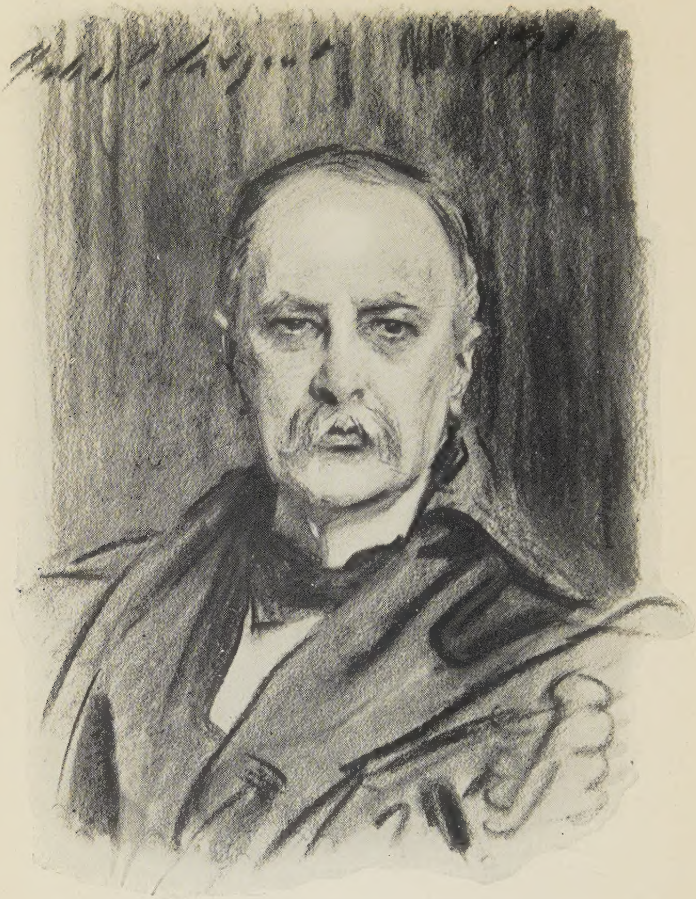

SIR WILLIAM OSLER

After a crayon portrait by John S. Sargent. Reproduced by permission of the College of Physicians of Philadelphia

MUCH HAS BEEN DONE, MUCH REMAINS TO DO; A WAY HAS BEEN OPENED, AND TO THE POSSIBILITIES IN THE SCIENTIFIC DEVELOPMENT OF MEDICINE THERE SEEMS TO BE NO LIMIT. *Æquanimitas.*

THE FACTS OF MODERN MEDICINE

A Simplified Statement of Established Knowledge on Medical Subjects, with Reference also to Certain Current Misconceptions

BY

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TO

DR. ALFRED WORCESTER

PROFESSOR OF HYGIENE IN HARVARD UNIVERSITY

A WISE AND SYMPATHETIC COUNSELOR TO MANY

PREFACE

Public knowledge of medical matters has sometimes been described as that knowledge which was possessed by the medical profession of the generation before. To-day, however, this is far from true, for so rapid and so complicated have been the medical advances of the past two generations that popular understanding has lagged farther and farther behind. Only those with some training in science can comprehend the revelations of the microscope, of modern chemistry, and of elaborate recording and measuring instruments; they are not susceptible of explanation in terms of everyday knowledge. Hence, although the conclusions or deductions drawn from medical science are often described to the public, the average layman is rarely in a position to grasp them intellectually, for he is unable to correlate them with his own observations. Popular knowledge has not yet gained access to the basic facts underlying modern medical progress, and consequently the gap between the knowledge of the general public and that of the medical profession is constantly increasing.

This situation is discouraging to all concerned, and this volume is written with the purpose of remedying it. The specialized education of the medical profession has been considered with such thoroughness as is consistent with the scope of the volume, each successive subject in the medical course being described to the reader, so that he may follow, in simplified form, the same branches of the science that are studied by every physician. It is the author's hope that if the basic facts of medical knowledge are thus made available to the educated public, a better mutual understanding between the public and the medical profession will result.

The book is intended also to help the beginning medical student to approach more understandingly the actual work of the medical school. The course in medicine occupies at least four academic years and involves detailed consideration of many subdivisions of the science. It begins with the minute study of every bone of the body, of each separate muscle, and of the microscopic structure of all organs and tissues, followed by other seemingly unrelated facts in close succession. In the earlier parts of the course, the student is so occupied with this necessary detail that he is for the most part unable to appreciate the full significance of what he is learning, or to see the practical bearings of these preliminary facts as they will ultimately contribute to his understanding of the whole field of medicine. Often he begins blindly, memorizing laboriously many unimportant items, while missing many opportunities to devote adequate attention to points of unsuspected importance. His position is that of one who builds without ever having seen the plan.

Much of this uncertainty would be removed if the student were first given a preliminary view of the whole subject, drawn in broad outline but with all its parts in true perspective. It is hoped that this book will enable the prospective student of medicine to make such a general survey of the entire field in preparation for the subsequent intensive work, and that the difficulty of medical study may be lessened as a result.

If, by this simplified summary, the efficiency of medical education will be increased, while the general knowledge of medical matters by the laity is also advanced, the author will feel doubly rewarded.

Friends too numerous to be tendered recognition individually have given valued assistance in the production of this volume. It was at the suggestion of a number of these that the work was first undertaken. Others have given helpful advice throughout its preparation. Colleagues in the medical profession have reviewed the material to guard against misstatements. Lay critics have advised as to its selection and manner of presentation.

Indebtedness must be expressed to collaborators in the author's medical publications, *The Specialties in General Practice* and *The Art of Medical Treatment*, for much authoritative information on special subjects.

Dr. Alfred Worcester, Professor of Hygiene in Harvard University, has been kind enough to give careful attention to the prelimi-

nary manuscript and to offer suggestions all of which have been incorporated.

Dr. S. Burt Wolbach, Professor of Pathology in the Harvard Medical School, has, in addition to other favors, contributed the photomicrographic illustrations from the collection of his department.

Dr. James B. Ayer, Professor of Neurology in the same institution, has given advice with special reference to diseases of the nervous system.

Miss Helen J. Tibbetts has been of constant assistance in adjusting the manner of presentation to the viewpoint of the educated public.

Miss Etta R. Piotti has done much to lessen the crudity of the author's drawings.

By arrangement of the publishers the text has had the benefit of a thorough editorial revision by Miss Mildred Blumenthal, who has assisted also in the reading of the proofs.

F. W. P.

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PRELIMINARY CONSIDERATIONS

THE FACTS OF MODERN MEDICINE

CHAPTER I

INTRODUCTION

THE purpose of this book is to promote among the laity a better understanding of medicine. It is a constant source of astonishment to physicians to find that patients, otherwise well informed, understand practically nothing about health and disease. Their ignorance of elementary facts renders explanation of disease difficult and frequently useless. This is largely in keeping with the age in which we live; today it is necessary for each individual to acquire so much specialized knowledge that all learning not immediately necessary to the promotion of livelihood is sadly neglected. Regardless, however, of any cultural interests or activities which may engage attention during leisure, precise knowledge about health and disease is indispensable for all. Accident, disease, old age, and death are inherent in life. Immunity is granted to none and, in its last analysis, health is synonymous with efficiency, adjustment, and harmony. Yet most people know comparatively nothing about medicine and give no thought to it until disease overtakes them. Moreover, the development of preventive medicine has resulted in the establishment of numerous public health measures which must be administered and maintained, not by the medical profession but by the laity; and an enlightened interest in public health and the adoption of such other prophylactic measures as will contribute to the general welfare are largely dependent upon the prevalence of a fundamental knowledge of health and disease. These are some of the practical reasons why it is necessary for every individual to understand the basic teachings of medicine.

Another purpose of this volume is to correct some current misconceptions. Among the various specialized branches of human knowledge, medicine occupies a peculiar position. In addition to the fact that the laity know practically nothing about it, current ideas in regard to medicine have always been shrouded by more or less mystery and mystification. Throughout history, unfortunately, it has been confused with magic and sorcery, and to some extent this association still tinges the popular conception of it. Moreover, a tendency to theorize upon health and illness seems to be inherent in human nature, and this tendency is usually curiously impervious to facts. It has created the nuclei for the establishment of various sects to which individuals adhere so fanatically as to develop a hostility to all contrary ideas which prevents them from investigating scientific evidence. Various obsessions and phobias in regard to remote possibilities of disease frequently contribute to such a state of mind. Thus, while the public is content to depend entirely upon expert opinion in other applied sciences, confusion is rampant in medicine because of fanciful notions and widespread erroneous opinion which is more deplorable than total ignorance.

The subject of medicine is too vast to be known in detail save by those who devote their lives to it, but it is entirely possible for any one who desires to concentrate attention upon it to comprehend its essentials. It is true that much remains obscure or unknown, but its fundamental facts are as definitely beyond dispute as are the laws of physics and chemistry. In this volume an attempt has been made to give a comprehensive outline of medicine from its foundation to such practical application of its teachings as is already established, with due regard to the limitations of present knowledge.

Books containing medical information for lay readers have been written before, but as compared with popular books upon other applied sciences they have not been numerous. Moreover, many of them are variously open to serious criticism.

They may be classified into several more or less distinct groups as follows:

1. Books purporting to be "family medical advisers" which are published in response to the desire of patients to treat themselves without consulting a physician. In their more pretentious and undesirable form such books are less in evidence now than formerly. Most, if not all, of them are dangerous, not only by reason of the general attitude which they encourage, but because the specific advice contained in them is frequently erroneous.

2. Books attempting to promote some new fad which the medical profession as a whole does not endorse. Medical knowledge based upon such books is unsafe since past experience has demonstrated that most, if not all, of the theories promulgated in this way have ultimately proved to be fallacious.

3. Fraudulent medical literature, which is now somewhat less flagrant than it formerly was, but is still by no means under control. All of this literature is harmful to a degree. It ranges from pamphlets merely advising the purchase of some preparation at a drug store to advertisements and personal correspondence intended to induce the reader to pay for expensive treatments, even surgical operations, which honest medical opinion finds unnecessary. Such quackery relies upon the instinct of fear which it fosters by various methods. It has caused untold mental suffering, in addition to considerable financial loss.[1]

4. Books on "first-aid" medicine and surgery. These are numerous, and are for the most part sound so far as they go.

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[1] See the volumes *Nostrums and Quackery* published by the American Medical Association. Also the columns "Propaganda for Reform" appearing in the *Journal of the American Medical Association.*

They have a place in teaching the laity what to do in emergencies, and how to avoid danger and neglect before a physician can take charge. If the reader does not exaggerate their importance and the advice they give is heeded, namely, that a doctor should be called even if first aid is rendered, a knowledge of their contents is valuable. But there is danger that a layman with a smattering of medical knowledge may attempt to do more than the book advises and thus work injury. Moreover, first-aid books give little general information upon medical subjects.

5. Other books of popular information on medicine.[2] A few of these are eminently sound in their teachings and admirable in their purpose; but, excellent as some of them are, they have not yet served to develop such understanding of medical matters as is desirable. Neither have they corrected certain popular misconceptions.

All of the writings classified in the first three groups are mentioned only to be condemned; those embraced in the last two are of value, but it is hoped that the present volume may be of service to supplement their teachings.

It is fast becoming recognized that the public should be given an opportunity to learn more about medicine. To this end the Medical School of Harvard University has for more than a decade conducted public lectures in which the author has participated. In the past the medical profession has been opposed to public medical instruction largely because it was honestly held that such instruction would be productive of more harm than benefit. Many physicians are still of the same belief. Certainly it is a fact that medical information inadequately understood, misunderstood, or misapplied may result in much harm. This opposition, however, is lessening. The dangers of popular attention to medical subjects do not lie in an understanding of facts by those capable of assimilating them; they lie rather in erroneous impressions derived from partial or imperfect understanding of facts. Fear of disease is easily aroused, although in varying degrees, as quacks know too well. To eat of the tree of knowledge may be fatal, but it is also the road to freedom. When one learns of a disease, it is natural to fear it, and a certain emotional and mental stability is required to realize that the chance of contracting it is comparatively remote. Undoubtedly, many timorous persons exist, as well as some with distorted ideas, who are so predisposed to fear disease that they are incapable of objective interpretation of medical facts. But this is no reason why enlightened individuals not subject to disturbance of emotional balance, who are fortunately in the majority, should remain in ignorance. Sound information imparted in such a way that it is assimilable in proper perspective and without misconception can only redound to the welfare of the individual. What follows is presented with the hope of furthering this object.

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[2] The desirability of such books is emphasized by the fact that one has recently been published by officers of a large life insurance company.

The attempt has been made to include only established knowledge, namely, facts generally accepted by the medical profession. Therefore, if statements are encountered which are not clear to the reader, the family physician will be able to supply the necessary explanation.

CHAPTER II

THE LAYMAN'S POINT OF VIEW

At the outset, something should be said concerning the mental attitude conducive to the best approach to medicine. For it is a subject which may be viewed from two different angles. Some will regard it from the personal aspect, focusing attention upon it in terms of individual health and welfare, that is, in its personal, practical application. Others will survey it objectively as a branch of human knowledge in itself worthy of study, its practical significance being considered chiefly from its bearing upon public health and the welfare of mankind. Persons of the first class, in learning of a disease, will wish to know chiefly whether it is likely to attack them or their families, and in that event with what results; those of the second class will study the disease to learn scientific facts, without consideration of their own lives, as they might investigate any biological phenomenon.

It is primarily for those who can attain this broader view that this book is written. Medical science will be described in such detail as is commensurate with the scope of the volume; but as most readers will find it difficult to retain an impersonal range of vision at all times, an attempt will also be made to portray the present status of medical practice in its relation to the human element, with observations on human reactions in the presence of disease, which are not always consistent with logic or facts.

Most people of ordinary intelligence give little thought to health and disease save when illness actually overtakes them. While they realize from time to time in the course of their daily existence that health is vulnerable and life is fleeting, personal illness is an unpleasant thought, and the possibility of it for them seems remote. But when illness does appear, it immediately dominates the attention. Patients usually wish to know all about their diseases and, in proportion to their mental acuity, they focus upon them in the same manner in which they have been accustomed to attack other personal problems. They attempt to gain full information from the doctor, and are also likely to theorize independently. As a rule, however, their previous knowledge of medicine is insufficient to permit of an adequate grasp of what the doctor can tell, and their theories are usually fantastically at variance with the facts. But until this interested curiosity subsides in the convalescence, there is an unsatisfactory state of uncertainty proportionate to the intellectual endowment. When the patient recovers he usually promptly forgets about the illness, and frequently is taught no lesson by it, as inattention to the rules of hygiene testify.

This attitude is unfortunate, but it is not to be condemned too severely, since the tendency not to ponder on illness is much more wholesome than is the opposite state of mind. There are persons whose attention is so morbidly concentrated upon their bodily sensations and physiologic processes, and in whom fear of disease is such an obsession, that, even in its absence, the erroneous convictions resulting from their oversolicitude render them unequal to the demands of daily life. Even in the presence of physical disease, in otherwise normal individuals, exaggeration of its significance is frequently the greatest source of unhappiness.

But in medicine, as in all departments of life, there is a happy medium which promotes understanding more readily than either extreme. The well-informed layman should have a knowledge of medicine in keeping with his knowledge of other matters. Moreover, he need have little difficulty in obtaining it. The mystery with which the subject has been shrouded in the past vanishes with little study, and many intelligent indivduals, prevously indifferent to it, become intensely absorbed when once their interest has been aroused. It is to be hoped, therefore, that in the future a sound understanding of medicine will prevail. Such enlightenment is not only necessary to the education of the individual, but to his attainment of responsibility and leadership among his fellows. Those who are more enlightened should be in a position to impart sound medical information, as well as that incidental to other matters, to those of lesser education.

It may perhaps be of value to enumerate some of the advantages which may be expected to accrue from medical education of the community at large. These are: (1) The enactment, maintenance, and improvement of public health measures. Such measures are of great importance, as illustrated by the diminished incidence of smallpox, typhoid fever, tuberculosis, diphtheria, yellow fever, and many other diseases. Although usually planned by physicians, preventive measures are possible only through their understanding and support by legislators and the public. (2) The promotion of individual safety in preventing disease, as well as in avoiding its aggravation by neglect or by erroneous treatment. (3) More intelligent coöperation with the doctor in disease, and the facilitation of better understanding between doctor, patient, and friends. (4) Last, but by no means least, is the satisfaction that redounds to the individual from a knowledge of facts, as opposed to vague fancies which frequently result in unwarranted fears.

It should be made clear, however, that a popular knowledge of medicine, desirable as it is, should not in any way diminish reliance upon the physician in the treatment of any particular case. Only general truths, to many of which there are exceptions, can be imparted to the public; the exceptions and their innumerable qualifying facts are determinable only after a thorough course in medicine supplemented by wide practical medical experience. In making a will or in entering upon a lawsuit it is generally unwise to proceed without the services of a lawyer, since the mismanagement of some unsuspected detail may upset the entire result; similarly, in illness and in questions of health the physician will frequently recognize that, to prevent an unfavorable outcome, some particular treatment of which the patient has no knowledge must be instituted, or some other measures must be distinctly avoided. To discard professional guidance is to court disaster.

CHAPTER III

PRELIMINARY SURVEY OF THE FIELD OF MEDICAL STUDY

THE study of medicine immediately becomes so intensely interesting to practically every student who enters a medical school that the medical writer and lecturer is frequently at a loss to understand the apparent apathy of the laity toward it. In the author's opinion, this prevalent lack of interest is due to the fact that the public has had little opportunity to learn the basic facts which must be grasped as a necessary preparation before any understanding of medicine is possible. The doctor's explanations and interpretations are frequently not understood because they fail to reach the level of patients who have had no fundamental training in his field; thus, much of what he says is incomprehensible to them. The physician's answers to a layman's questions are frequently so unsatisfactory that the subject is usually abandoned as hopelessly obscure. But with a proper introduction, which in itself is distinctly interesting, a satisfactory general comprehension of most medical questions will become possible.

It must be realized at the outset, however, that any thorough understanding of so vast a subject is attainable only through systematic study of the many branches of medicine, beginning with general fundamentals and proceeding in logical order to the more particular conclusions. As a preliminary, it may be useful to survey the field of study, and to indicate briefly how the discussion will be conducted with this object in view.

Medicine cannot be precisely defined for it is too complex. It is like a giant tree with many roots which contribute to its support and growth, extending upward in a profusion of branches and foliage which it nurtures. The roots of medicine are the many fundamental sciences which have contributed to the birth and growth of its ramified structure; the branches and foliage are the developments which have been and are ever being evolved and perfected. Broadly speaking, medicine may be defined as a science dealing with the physical existence of the human body, with special reference to the preservation of health and the treatment of abnormalities or disordered, affective states for the purpose of cure.

Birth, death, and the illnesses that intervene are outstanding facts in the physical life of every individual. Some thoughtless persons may give them little attention, birth being accepted as an accomplished fact and disease and death seeming too remote to be of any significance. All of these, however, present much that is interesting which is not immediately apparent, but which well repays examination.

For purposes of clarity it will be necessary to consider the subject in two successive stages: (1) that embracing the facts of normal human life; and (2), in the light of this understanding, that including the various departures from the normal. Like the lives of animals or of plants it should be recognized that human life has a more or less definite span. It has its origin in the fusion of two reproductive cells (*gametes*) derived from the parents. Under favorable circumstances it develops and flourishes for its natural period. Then it fades and dies. This normal course must be comprehended before its variations can be understood. Examination of the facts of normal human life involves *general biology*, together with a more minute study of *human anatomy* and *human physiology*.

But unfavorable circumstances may at any time cut short or affect the span of normal life. This may occur suddenly or gradually; it may be the result of injury, privation, poisoning, or of more complex and less obvious causes called diseases. And without affecting the duration of life, there may be temporary or permanent impairment of bodily functions rendering life less satisfactory, which may likewise be the result of injuries, privations, poisonings, or disease. All of them induce conditions within the body which constitute disease. The department of medical science which treats of the causes and nature of diseases, or abnormal physical conditions, is called *pathology.*

Many diseases are caused by entrance into the human body of microscopic living organisms known as bacteria, or by other living parasites. To comprehend pathology, therefore, it is necessary to understand *bacteriology* and *parasitology.*

These are the fundamental medical sciences, a grasp of which is essential to any thorough understanding of human disease.

Moreover, comprehension of the separate facts concerning particular diseases is dependent upon a general understanding of certain applied sciences fundamental in the practice of medicine. These are: (1) *diagnostic methods,* or the study of the means by which abnormalities in the body can be recognized during life; (2) *therapeutics,* or the study of the influences which can be applied to correct or to diminish abnormalities; (3) *public health* and *preventive medicine,* or the study of the prevention of disease in the individual and in communities.

All of these subjects must be understood before the practical facts of special diseases can be grasped. They are therefore described in a separate division of this book, namely Part I, "The Fundamental Sciences."

With this preparation it will be possible to study the many abnormal conditions which affect the human body. Since it is recognized that states of illness in individual instances are frequently of similar nature, each typical abnormality is mentioned by name as a separate disease, such as typhoid fever, or pneumonia, or diabetes. Part II of this volume is devoted to an explanation of the known and generally accepted facts concerning most of the large number of well-recognized, important disease entities.

It may deserve mention that this plan of presentation is based upon the order in which a student pursues the four-year course of study in a medical school. On admission some acquaintance with general biology is required, as well as an adequate general education including some knowledge of physics and chemistry. The first year of study is devoted in part to anatomy, which embraces the gross structure of the human body as revealed by dissection as well as its microscopic appearance. The remainder of the first year is devoted to physiology, or the study of the functions of the normal body in all their traceable details, which include physical, chemical, and mechanical processes. The second year is spent largely in the study of pathology, which includes gross and microscopic examination of the alterations which occur in organs and tissues during disease. This is supplemented by a study of the changes which take place in the body processes as abnormal departures from normal physiology. Bacteriology and parasitology are usually studied at the same time. Toward the end of the second year or at the beginning of the third year courses in diagnostic methods, therapeutics, and preventive medicine are given. The third and fourth years are devoted to the study of individual diseases, both those which form the large group of medical and surgical disorders, as well as those of special structures of the body frequently dealt with by specialists. Finally, after graduation from medical school, practically all physicians enter a hospital for one to two years, to learn how to apply what they have learned.

From this point onward the reader may be considered as a matriculated student in a course for the study of medicine. It should be understood, however, that what is presented in this book has been extremely condensed. It is a summary representing the lifelong studies and discoveries of innumerable medical investigators from the earliest development of medicine to recent years, whose reported writings fill large libraries. In this volume the subject has been so condensed that, despite the belief that what has been presented is correct, it has not been possible to mention certain exceptions to statements which are essentially, though not universally, true. Moreover, for simplicity, some descriptions are cast in terms which do not pretend to precise scientific accuracy. It is possible that physicians will have reason to correct certain impressions gained by readers of these pages. If so, the physician will doubtless be right, the misunderstanding being due largely to the author's attempt to generalize too broadly. But the volume is nevertheless presented with considerable confidence that the intelligent public and the medical profession will find it sound in principle.

PART I

THE FUNDAMENTAL SCIENCES

CHAPTER IV

ELEMENTARY BIOLOGY: AN INQUIRY INTO THE NATURE OF LIFE

All medicine is bound up in the fascinatingly mysterious vital principle known as life, and in any preparation for its study it is necessary to have a conception of what life is, or of what it consists. For despite its complex physical and chemical nature, life is a definite force. It embraces the origin, growth, and propagation of living beings or things, and the phenomena incidental to these processes, which include their plan of growth, their constant changes in the individual organism, and their processes of self-repair, all of these being the result of physical and chemical forces which act and react under laws so as to result in the evolution and development of the species. But life may at any time be destroyed or extinguished by death. It is a property only of the organic world, that is, of the animal and vegetable kingdoms, existing on the surface of the inorganic mineral world. In its last analysis, the nature of the force constituting life is the same in all living beings, and therefore life in man is understood more readily through an understanding of life in its simpler, more primitive forms.

This study of the various manifestations of life and the determination of its fundamental nature is known as the science of biology, which includes *zoölogy,* the study of the animal kingdom, and *botany,* the study of the vegetable kingdom. The element of life is common to both of these branches, and even the study of plant life sheds considerable light upon human existence. For the purposes of this book, however, the subject of vegetable biology or botany may be eliminated after noting that its fundamentals are closely parallel with those of animal life.

CELLS

The teachings of biology have revealed a somewhat new viewpoint as to the nature of life, and have introduced a conception which may be difficult to grasp immediately, but an appreciation of which is of great importance to an understanding of the human body. Briefly stated its essentials are as follows: Throughout the scale of life, that is, from man to the simplest plants, the bodies of all living things are composed of little particles or units called *cells,* which are visible under the microscope. Although these cells vary in different animal bodies and even in parts of the same body, they have, nevertheless, a general similarity of structure and composition which serves to identify and distinguish them from other particles of the inorganic mineral world, such as crystals. Any cell is therefore a unit of some form of living matter.

Cells are identified by their form, each one being composed of a clearly outlined mass of granular-looking substance called *protoplasm* or *cytoplasm,* within which there is a distinctly different inner portion called the *nucleus.* The shape of the cell varies according to its type. Some are spherical or egg-shaped; others have square sides like little bricks; others are flat like wafers or spindle-shaped with two pointed ends; others are irregular in outline and may have long extensions. All, however, are formed of a similar outer substance within which there is a recognizable nucleus.

All animal cells, regardless of the size of their host, are about the same size, usually between one-fiftieth and one-hundredth of a millimeter in diameter. Fundamentally, their chemical composition is likewise the same, although special cells may reveal variations superimposed upon a similar base. Their protoplasm is composed chiefly of nitrogen, hydrogen, carbon, oxygen, and sulphur, in a molecule or molecules so complex that the exact formulæ have not yet been determined. The nuclei have their own somewhat different chemical content.

These cells, therefore, are the units of which all animal bodies are composed. Moreover, it should be understood that cells are not merely bits of inert, building material; on the contrary, each individual cell is alive and leads its own life among the surrounding cells, possessing its share of the life that is possessed by the body as a whole.

An understanding of the nature of the living cell comprising the unit of life in the body will be facilitated by a study of the simplest forms of cellular life in the animal kingdom. The number of cells in any animal body is proportionate to its size. In man the estimated number is so great as to be almost meaningless; in small rodents, like mice, they are still incalculable. But in the lower forms of animal life invisible to the naked eye, like the organisms in a drop of water, a high-powered microscope may render them calculable; and in the most primitive form of life in the animal kingdom there are minute bodies that live independently which are composed of but a single cell. In these, life in its simplest terms may be studied.

THE AMŒBA

One form of unicellular body, known as the *amœba,*[1] is a microscopic organism of which there are several varieties, some of which abound in the stagnant water of swamps. They are little bodies which, when magnified several hundred times, appear as large as a pea, and somewhat irregular but roughly spherical in shape. When a drop of swamp water is placed under a microscope, they are found to be little masses of a homogeneous, finely granular substance, each having a readily visible internal structure consisting of a round central portion called a nucleus, within an outer substance known as protoplasm. Nevertheless, on close observation, movement and processes of change are discernible in these minute single-celled animals. They are units of living matter endowed with the mysterious spark of life.

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[1] The bacteria, described in a subsequent chapter, are even more primitive, but possess characteristics common to the vegetable kingdom, although they are so low in the scale of life as to be scarcely classifiable as either animal or vegetable.

The existence of an amœba is sluggish. It has no power to swim actively, but it can stretch itself in fingerlike extensions and change its shape. For the most part, it drifts passively in the current of water in which it lives, but by means of its sluggish alterations of shape it can move a little to or from light, or toward food. It is able to surround minute food particles with which it comes in contact, and then to digest and assimilate them, and from time to time a little bubble of liquid is discharged as waste through the surface of the cell. Thus, it possesses some motility and other vital processes, including some rudiments of perception and decision.

Reproduction in the amœba is non-sexual; it is a simple process of division. One amœba is able to divide itself into two, and each of these can divide again, so that under favorable circumstances the first amœba may be multiplied by such division into innumerable millions. Through this process the life which was present in the original amœba has been passed on to existing amœbæ.

Thus, the amœba is a single living cell which performs all the functions of independent animal life without assistance. Here if anywhere the fundamental nature of life should be traceable. The solution of its mystery, however, is still remote. Simple as the amœba seems, its exact chemistry is undetermined; nor should it be imagined that chemistry can explain the formation of even this simplest living cell. Just as the hen is produced only from the egg and the egg only from the hen, so even the amœba can come into existence only as the offspring of a parent amœba. No animal cell can be formed except as the result of an elusive something inherited through an infinite line of ancestors, and by which the distinc-

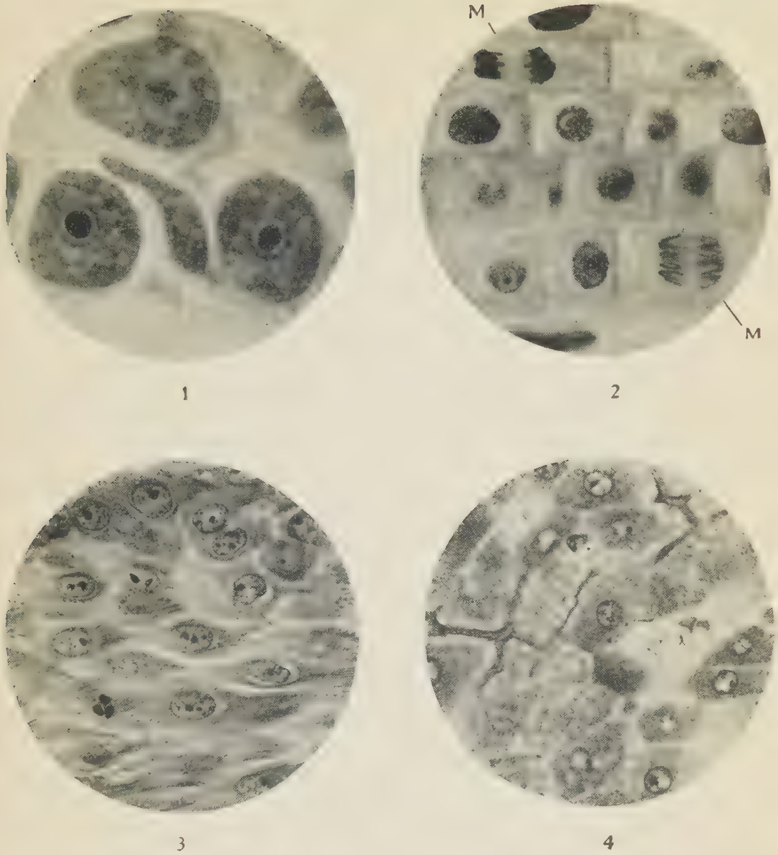

Fig. 1.—Photomicrographs illustrating cellular structure

1, amœbæ. 2, onion root. 3, human skin (epidermis). 4, human liver. In 2 note at M,M the appearances of the nuclei indicative of cell division in the process of growth The original photographs from which these are reproduced, with some diminution in size, were taken with a magnification of 1,000 diameters. 2 and 3 are from S. B. Wolbach, M.D., *New Growths and Cancer,* by permission of the Harvard University Press.

tive cells of any species have the capacity to take up formless, nutrient material from without so as to construct new cells like the parents. Life in any cell or aggregation of cells is not an accident of chemistry; it is rather like a spark of a fire mysteriously kindled long ago and fed for untold ages. Under conditions suitable for survival this firelike something continues, generation after generation. But in any individual cell it may be easily extinguished, and if extinguished it cannot be rekindled.

CELLS OF THE HUMAN BODY

As mentioned, the human body is composed of innumerable, separate cells each of which approximates the size of the amœba. Each likewise has its protoplasm and nucleus, and, so far as determinable by chemistry, the protoplasmic and nuclear substance of all cells are fundamentally similar in composition. Thus, both in microscopic structure and in chemical composition the living human body presents similarities with a mass of the same weight composed of living amœbæ. Moreover, if the development of the body of one of the higher animals or of man is traced from its origin in matter derived from its parents to its development into the final form characteristic of its species, there is more conclusive reason to recognize the fundamental similarity of the nature and behavior of the animal cell in its lowest and highest forms. As will be described in more detail in the chapter on reproduction, the human body like that of the higher animals has its origin in a single cell called the *ovum* or egg, composed of protoplasm and a nucleus. This single cell from which man originates is not a simple but a combined cell, formed by the fusion of two cells, one from the male parent and the other from the female parent. It may nevertheless be considered as a single cell, a nucleus with its protoplasm, similar to the amœba.

But the difference between the cellular structure of man and a mass of collected amœbæ is this: As the amœba has no higher state of development, the divisions of the amœbic cell can only form other cells or amœbæ similar to the original; while the cells which represent the eggs of animals or of the human species, known as *fertilized ova,* possess an inherent quality which predestines them to change, as they divide and redivide, into cells which are different. The single fertilized ovum looks essentially like an amœba, save for its greater size; but as its one cell becomes two, and as these two in turn become four and so on, the resulting cells arrange themselves spontaneously to correspond with a plan of growth, ultimately forming the adult body with its various *organs* and *tissues.*[2]

The human body, therefore, is an aggregation of myriads of microscopic cells, each one containing a nucleus and protoplasm, all of which have appeared, by subdivision, from a single cell or unit of living matter closely related to that of all other forms of animal life, but which have developed into their characteristic structure by progressive alterations. Microscopic study reveals that nearly all of the cells of the various tissues of the body have assumed particular forms and types of arrangement which render them only generally similar in appearance to the original ovum or to the amœba. The appearance and behavior of the white corpuscles of the blood, and certain other cells of the adult human body are still practically identical with those of amœbæ. But these are in a minority. In contrast, there are the cells of the skin, of the muscles, of the bones, of the internal organs, and of the nervous system, all of which have very special forms and arrangements. Each separate cell is still a unit having its individual life, but it has become quite different from its ancestors, its particular characteristics depending upon the organ or part of the body structure with which it is identified. Moreover, a study of the human body will reveal that these different cells of the

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[2] In the early stages of its development from the fertilized ovum or zygote, the newly forming body is known as the embryo; after it is fully formed but while yet unborn it is termed the fetus.

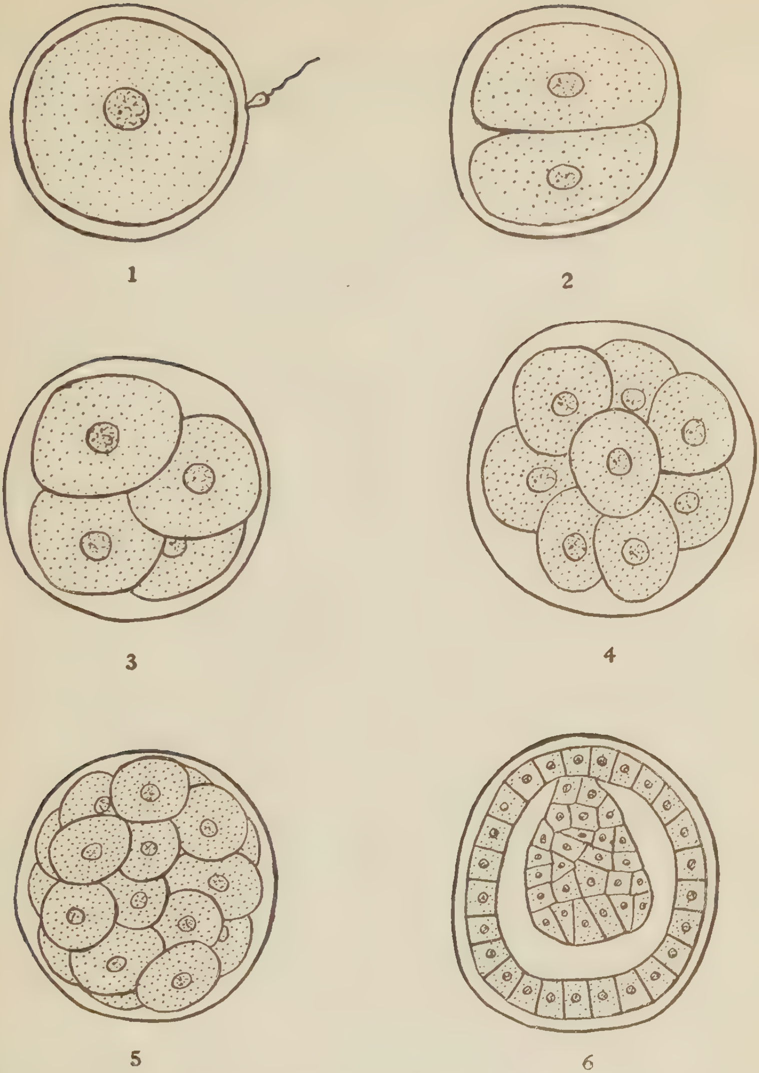

FIG. 2.—DIAGRAMMATIC REPRESENTATION OF THE OVUM AND THE FIRST STEPS IN THE DEVELOPMENT OF THE EMBRYO

1, ovum with spermatozoön entering; magnified approximately 300 diameters, since in actual size the human ovum is about one-sixteenth as large as the dot of an *i* in ordinary print. 2 to 5, successive divisions of each single cell into two; for convenience, the increasing size of the whole is not represented. 6, represents a cross-section at a considerably later stage, in which the cells have grouped themselves in a definite arrangement, a central mass within an outer layer.

various organs and tissues have assumed their special characteristics in order to fulfill their particular function incidental to maintaining the work of the body as a whole—the entire process representing a remarkable scheme of coöperation or division of labor. The cellular life of the body is therefore interdependent, that is, each cell has become entirely dependent upon the functions of all other cells.

In the amœba one primitive cell is self-sufficient, doing everything necessary to support life; it is somewhat like a pioneer in the wilderness. The cells of the human body on the contrary are like members of a highly civilized community who might be wholly incapable of sustaining themselves in the wilderness, but are able to live more comfortably in their respective homes because of their division of labor. The single cell of the amœba has some power to alter its shape; in the cells of human muscle this power is much more highly developed so as to accomplish muscular contraction. The single cell of the amœba performs all functions of digestion and of excretion of waste products; in man, these functions are divided between the special cells of separate organs. The amœba has slight powers of perception; in man, perception, as well as the other functions of nerve tissue, is accomplished by means of very highly specialized cells of the nervous system. Moreover, life in any cell of the human body depends upon life in all, or almost all, the others. If a few of these cells sicken or die the others may still live, but if any vital portion of them dies, all of the others die in consequence.

Thus, life in the human organism permits of two conceptions: (1) It may be considered in the ordinary sense of life and death of the body as a whole, that is, in terms of the presence or absence of such general functions as consciousness, breathing, and the heartbeat; or (2), from the biological point of view, as the composite life of myriads of separate cells each of which is a living unit. This second conception may seem confusing and remote from the facts of common observation;

and, in the process which constitutes death, a differentiation between these two conceptions may be of little significance, since death of the body as a whole is promptly followed by death of all its cells. In the consideration of health and disease, however, it is important to know that the unit of life in the human body is the microscopic cell, and that the explanation of disease is frequently found in disorder of these microscopic units.

The biological conception of life, therefore, may be summed up as follows: (1) Life is an undefined property or principle residing in microscopic units of living matter called cells. (2) All living bodies are composed of these cells so arranged and so equipped with special properties as to sustain each other through mutual coöperation. (3) Human life, in its ordinary sense, is the combined result of the harmonious coöperation of the innumerable cells which compose the human body. In reality the nature of human life is composite, made up of myriads of individual lives of single cells each of which is descended and has inherited its life from that single ancestor cell, the fertilized ovum; but so dependent are all of these cells upon each other that, for practical purposes, the life of one is the life of all, and if any one variety of cells ceases to perform its functions, the death of all cells and of the body as a whole promptly results.

CHAPTER V

ANATOMY AND PHYSIOLOGY

In any presentation of the study of medicine, no matter how cursory, it is necessary to obtain a knowledge of the structure and functions of the body in health. The appearance and activity of the human body is so familiar that most persons accept it as a fact, giving it no particular thought so long as no part of it presents symptoms of pain or discomfort. An intellectual worker who is able to sit at a desk, make wise decisions, sign his name, and walk home, or a manual laborer who can do a day's work, gives no more thought to the structure and mechanism of the body than he does to the power station which controls his use of the telephone.

But if the human body is considered from the standpoints of anatomy and of physiology it soon becomes evident that it is one of the greatest wonders of the universe. Just what constitutes the remarkable phenomenon of life and consciousness still defies analysis, but it is therefore all the more marvelous. From the more readily comprehensible mechanical conception, the human body, considered as a heating plant and an engine, generates an astonishing amount of heat and mechanical power in proportion to its consumption of fuel in the form of food. The regulation of the body heat is amazingly perfect. The movements performed in writing, or in playing baseball result from a harmoniously arranged system of muscles acting upon the bones as levers, under the guidance of vision, the sense of touch, the will, and the understanding, all of which are embodied in the nervous system. Digestion, the circulation of the blood, the absorption of oxygen from the air by the lungs, the excretion of waste products, and that most wonder-

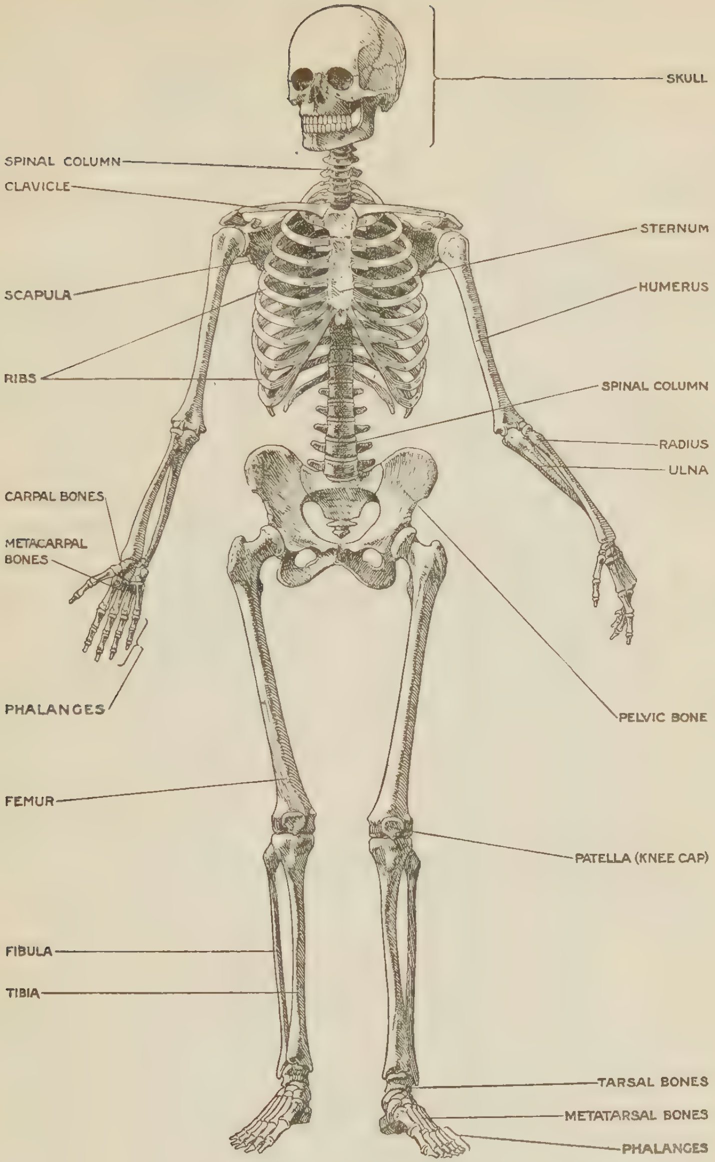

FIG. 3.—THE SKELETON OF THE HUMAN BODY

From Ritchie, *Human Physiology*; copyright, 1920, by World Book Company, Yonkers-on-Hudson, New York.

ful process which constitutes reproduction are phenomena that appear more marvelous the more that is known about them. The special senses of sight, hearing, taste, smell, and touch are remarkable in themselves.

Many readers of these pages undoubtedly possess some knowledge of anatomy and of physiology, perhaps in more detail than will be given here. And there are excellent school textbooks on these subjects, especially of anatomy, which may be consulted if more precise descriptions of special structures are desired. However, as it is the object of the following presentation to describe only such matter as is necessary for a comprehension of disease, many details will have to be omitted in order to give due emphasis to essentials.

It is well to consider the body as composed of two groups of organs: (1) that comprising its mechanical structure and covering, consisting of the *skeleton,* the *muscles,* and the *skin,* which give the body its appearance and form, and contribute most to its external existence, but which on the whole are of lesser importance in reference to disease; and (2) that comprising its more vital organs, such as the *heart,* the *lungs,* the *digestive organs,* the *kidneys,* and the *brain,* which serve to maintain life and efficiency in the body as a whole and which are more susceptible to processes of disease. Each of the structures constituting these two groups will be considered separately.

THE SKELETON

The body receives its shape from a framework of bones—the skeleton. This is composed of long bones, such as those of the arms, legs, and ribs; of short or irregular bones, such as the vertebræ which, in a chainlike column, constitute what is known as the "backbone" or vertebral column; and of flat or platelike bones, such as those composing the skull which form a protected cavity for the brain.

All of these bones are separate but are connected by joints,

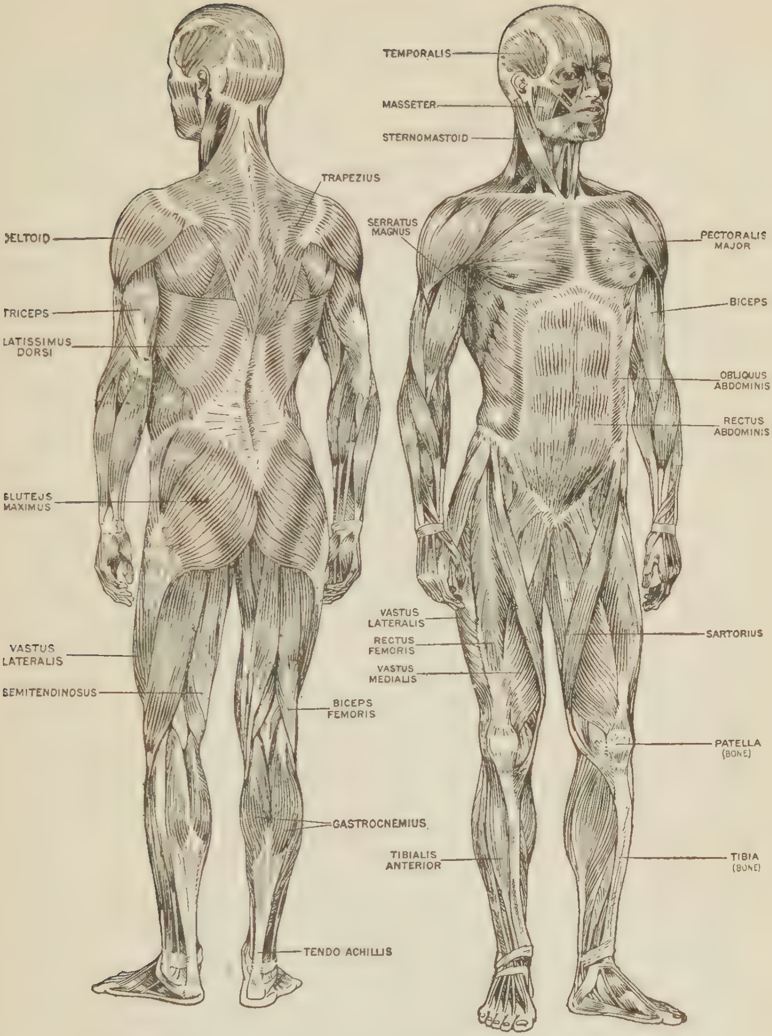

FIG. 4.—THE OUTER MUSCLES OF THE BODY

From Ritchie, *Human Physiology*; copyright, 1920, by World Book Company, Yonkers-on-Hudson, New York.

like hinges. These joints are all differently constructed, but each is so formed as to permit of such movements of its connecting bones as are necessary to facilitate motion and at the same time to resist abnormal movements as, for instance, forward bending of the lower extremities at the knee. The surfaces of the bones, where they come in contact with each other, are covered by smooth and slightly elastic coatings of *cartilage* or *gristle*. About these apposing surfaces the two bones which meet in the joint are bound together by tough, fibrous-tissue[1] *ligaments,* somewhat as two glass rods may be flexibly joined together by inserting one end of each into a piece of rubber tubing.

In addition to supporting the general form of the body, the bony framework or skeleton apparently performs two chief functions: (1) It affords protection to organs which lie in cavities enclosed within it—the brain within the skull, and the heart and lungs in the chest under the ribs; and (2) it serves as a complicated arrangement of jointed levers upon which the muscles operate to produce motion.

Bone is a special form of body tissue that owes its hard and brittle quality to its particular composition, which is largely a deposit of lime salts, chiefly calcium phosphate, filling the spaces between the bone-cells.

THE MUSCLES

The muscles cover and surround the bones of the skeleton (except in a few places where the bones are felt directly beneath the skin), and form a large proportion of the total bulk of the body. It is chiefly the muscles which round out the body and limbs by supplementing the meager proportions of the skeleton. Meat is the sliced muscle of animals.

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[1] The word tissue in medical terminology denotes substance or material of some uniform kind. Thus the substance of any part of the body may be referred to as tissue in terms of its special structure, that is, heart tissue, liver tissue, muscle tissue, etc. When used in the plural, it is applied to structures of the body not sufficiently defined as entities to be designated organs.

But the muscles should not be regarded as mere flesh or padding. Each muscle—and there are hundreds of separate ones all arranged in an extremely complex but beautifully ordered manner—is, for practical purposes, a cord which has the capacity to contract. When contraction occurs, movement results. For the most part, each muscle is attached by one end to a bone above a joint, and by the other to another bone beyond the same joint. Thus, when a muscle contracts, it causes the two bones to move upon each other at the joint. In their action the muscles resemble the strings of a jumping-jack.

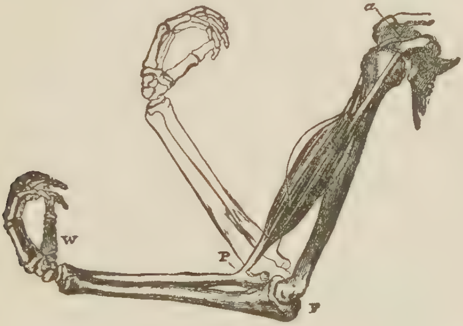

FIG. 5.—DIAGRAM OF THE BICEPS MUSCLE AND ITS ACTION

From Huxley and Barcroft, *Lessons in Elementary Physiology*; courtesy of The Macmillan Company of New York and Macmillan & Company of London.

The *biceps muscle* may be used as an illustration. This muscle forms the bulge in front of the upper arm; at its upper end it is attached at the shoulder, at its lower to the bones of the forearm just below the elbow-joint. When this muscle contracts or shortens, it pulls upon both of its attachments; and, since the lower attachment is the one more easily moved, the forearm and hand, unless restrained, are drawn upward, the arm bending at the elbow.

The *triceps muscle,* which lies behind the upper arm, acts in an opposite manner. It is attached below to the backward extension of the bone of the forearm (*ulna*) behind the hinge of the elbow-joint. Therefore, if the triceps muscle contracts while the elbow is bent, it pulls the point of the elbow upward and causes the forearm and hand, beyond the hinge, to move downward.

It is of interest to note that in animals and birds the fundamental plan of the muscular system, even so far as the presence of special muscles such as the biceps and the triceps, is strikingly similar to that of the human body.

Every one of the many muscles of the body has a definite action and purpose. Most movements of the body, however, are effected, not by the action of any single muscle, but rather by the simultaneous contraction of groups of muscles. Thus, in clenching the fist, a number of muscles in the forearm contract and pull upon long cords called *tendons,* which pass in front of the wrist through the palm of the hand and down to the tips of the fingers; and the action of these larger muscles is supplemented by contractions of smaller muscles in the hand and fingers. In ordinary movements most muscles act in groups, but for the performance of special movements the muscles are capable of grouping themselves variously, to serve each particular purpose.

The finer movements of the hand, particularly those involved in writing and in sewing, are possible only because of extremely complex and efficient systems of muscles, small as well as large, which are capable of acting in innumerable combinations. The human hand is extremely versatile in its mechanical ability to perform special movements. A moment's reflection will serve to show that, just as the human intelligence is superior to that of animals, so the human body in its mechanical aspects is far more efficient than that of any animal. Animals may be more highly specialized for some particular activity, as the greyhound for running or the bird for flying. But man is so constructed mechanically that he not only has a power to move about, which is adequate to his needs, but he can do many things which no animal could do, even if endowed with human intelligence. Trained dancing, throwing a baseball, playing tennis or golf, using tools, writing, drawing, and embroidery would be impossible if the human body were less perfectly constructed, however remarkable the mind might be. In fact, there is ground for surmise that man's intellectual development is in a large measure the result of the mechanical versatility of the human body.

The muscles, therefore, are those structures by which all outward activities are performed. A large part of the entire body is made up of numerous separate muscles, each one of which may be considered as a contracting structure which can pull in a certain direction. The signal in response to which any single muscle contracts comes through a *nerve*.[2] Thus, the muscles do their work only in response to neural impulses. They are, however, the structures which provide the motor power of the body, and they are ready at all times to exert this power at a given signal. We may liken them to the charged cylinders of an engine awaiting ignition to liberate their energy.

Each muscle, however small, is composed of myriads of minute fibers which are special forms of body cells. Each of these cells, on microscopic examination, is found to have many fine lines drawn across it at right angles to its greatest length. When the muscle is relaxed these cross lines of the cells which compose it are slightly farther apart, and when the muscle is contracted they are perceptibly closer. Contractions of the entire muscle, therefore, seem to consist of a shortening of each of the microscopic cells which compose it, and this shortening is effected by an approximation of still finer structures within each cell.

The contraction of muscle involves chemical changes which are known only partially and are too obscure for detailed discussion here save to remark that, like most of the body processes, the chief reactions are those of *oxidation,* or the combining of substances in the muscle with oxygen brought by the blood. In muscles this substance is called *glycogen,* and it is allied chemically to the starches and sugars. As the result of contraction, one product of the oxidation of glycogen in the muscles is *lactic acid,* the accumulation of which is probably an important factor in the phenomenon of fatigue.

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[2] This is discussed in the chapter entitled The Nervous System and the Special Senses, p. 118.

THE SKIN

Over the muscles lies the skin, which forms the visible surface of the body; under the skin there is a layer composed chiefly of fat known as the *subcutaneous tissue.*

The skin serves as a covering of the body, but this is not its only purpose; it has certain other functions of considerable importance. It is composed of two layers. The actual surface is formed of a thin membrane or layer of cells, known as the *epidermis,* which would undoubtedly be dry and horny were it not always slightly lubricated by an oily or greasy secretion which is produced by microscopic structures called *glands* contained within the skin, especially in the hair roots. Probably the most important functions of the epidermis are to prevent the watery fluids of the body from oozing out, and external material from gaining access to the body.

The second or deeper layer of the skin is composed chiefly of tough, fibrous tissue corresponding to that material taken from animals for the manufacture of leather. In its living state it is moist and pliable, easily stretched, and rather freely movable over the muscles and bones beneath it, serving as a strong but flexible and elastic casing.

In addition to serving as a waterproof, protective envelope, the skin has two other functions: (1) It is the organ of the sense of touch, or more precisely of appreciation of contact, of heat and cold, and of such pain as may be produced by surface influences, receiving such sensations through minute bodies present in the skin and transmitting them by means of nerves; (2) sweating or perspiration, a process involving the discharge of water and of some salts and waste products

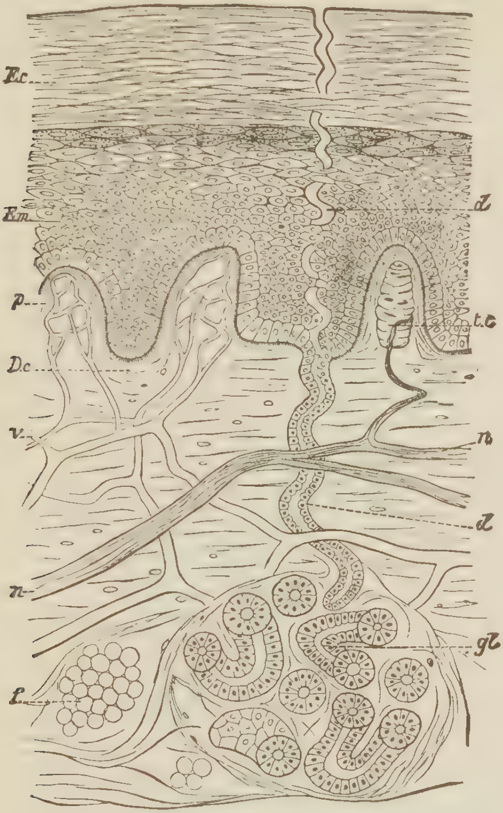

FIG. 6.—THE STRUCTURE OF THE SKIN

E.c., epidermis corneous part; *E.m.*, epidermis Malpighian part; *D.c.*, connective tissue of dermis; *p*, papilla; *gl*, sweat gland, the coils of the tube cut across or lengthwise; *d*, its duct; *f*, fat; *v*, blood-vessels; *n*, nerve; *t.c.*, tactile corpuscle. From Huxley and Barcroft, *Lessons in Elementary Physiology*; courtesy of The Macmillan Company of New York and Macmillan & Company of London.

to the surface of the skin, which is necessary to life, since it is an important factor in the mechanism by which an equable body temperature is maintained. If the body generates too much heat, as by exercise, the skin excretes moisture which, as it evaporates in the air, cools the surface of the body and so prevents its temperature from rising. The perfection of this mechanism of automatic heat regulation is astonishing, for the body temperature is kept constant in health within fractions of a degree.

Beneath the two layers of the skin proper, but over the muscles and bones, lies a loose webbing of fibers filled with masses of soft yellow fat, known as the subcutaneous tissue. The thickness of this fat layer is exceedingly variable in individuals, and it is chiefly because of this variation that, with equal bones and muscles, one person may be stout and another thin. This fat represents the accumulation which results when more food is ingested than is consumed in producing the necessary heat and power. To some extent it forms a reserve supply which may be drawn upon in starvation or in wasting diseases. Too little fat is perhaps undesirable but in health it is of no great moment; too much fat is inconvenient and uncomfortable, and, while not particularly harmful in itself, is likely to be associated with flabby inefficient muscles and subnormal body processes—an exaggerated form of what athletes call "out-of-training."

CONNECTIVE AND INTERSTITIAL TISSUE

An important body material which descriptions of anatomy frequently neglect is that known as *connective tissue*. Thus far, the skeleton, the muscles and the skin have been described as separate structures. As indicated in a previous chapter, the entire body is formed of cells derived originally from the ovum, but progressively altered in the course of their development to meet the particular function of the special organ they compose. But it is necessary to mention that the position of all these special structures is maintained by a form of tissue called connective tissue, or in its tougher forms, fibrous tissue, which serves as binding material. This connective tissue which

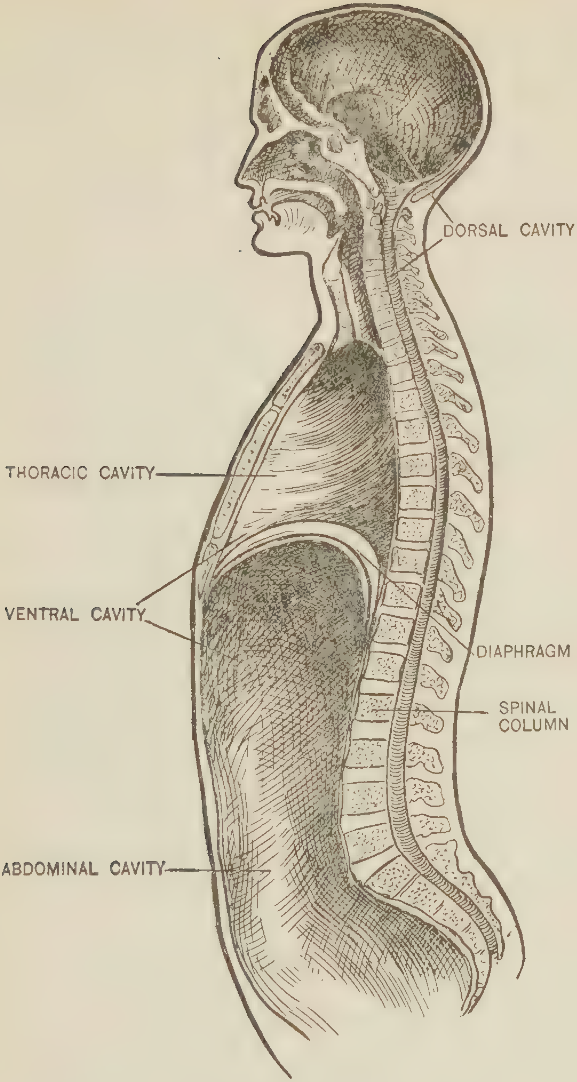

FIG. 7.—THE CAVITIES OF THE BODY

The dorsal cavity is in the head and the spinal column. The ventral cavity is in the front of the trunk and is divided by the diaphragm into an upper and a lower part. From Ritchie, *Human Physiology*; copyright, 1920, by World Book Company, Yonkers-on-Hudson, New York.

holds the entire body together is likewise developed from cells, but the basic cells of connective tissue are of a more primitive form than those of the muscles and the special organs. Furthermore, microscopic study of connective tissue reveals that it is not composed entirely of cells, but is in large part a stringy material which has been formed by cells. The process cannot be precisely explained; it is comparable with the manner in which a silkworm forms the fibers of its cocoon and lives within these fibers which are really not a part of it. The connective tissue cell has the property of forming fibers about itself, and it is the stringy material formed by these connective tissue cells which holds the body intact. The muscles are bound up

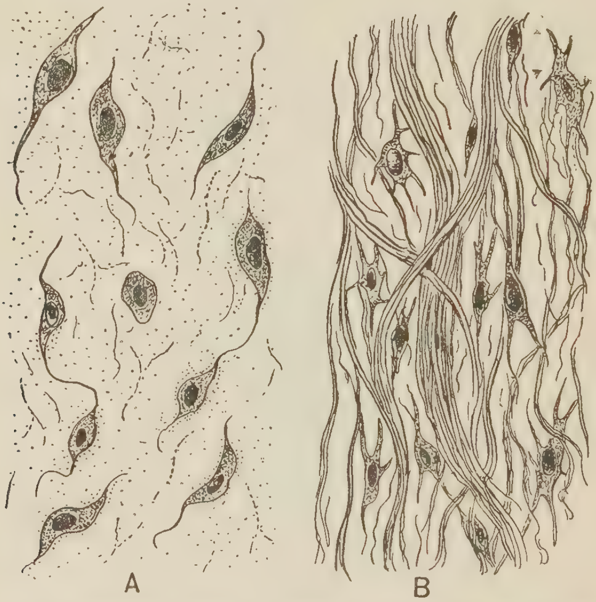

FIG. 8.—CONNECTIVE TISSUE, SHOWING FIBERS DEVELOPED ABOUT AND BETWEEN CELLS

A, more delicate form; *B,* tougher, more fibrous variety. From Ritchie, *Human Physiology*; copyright, 1920, by World Book Company, Yonkers-on-Hudson, New York.

in bundles by connective tissue envelopes; the tendons or cords by which muscles are attached to bones are connective tissue; the leathery layer of the skin is connective tissue; in the subcutaneous tissue the fat deposits are held in a web of connective tissue fibers; cartilage or gristle is a special form of connective tissue; and finally, the bones are really connective tissue save that, in addition to their cellular and fibrous structure, they are composed of mineral salts of lime deposited after the formation of their fibrous structure. Moreover, even after their work of forming these binding structures is completed, the connective tissue cells retain their capacity to form new connective tissue if at any time there is need. They are, therefore, the chief factor in the formation of scar tissue which repairs wounds.

THE INTERNAL SPACES OF THE BODY

The trunk of the body, so far as the skeleton, the muscles, and the skin are concerned, is the container for the internal organs. The vertebral column or backbone furnishes rigidity in the vertical direction. The chest or upper portion of the body is made rigid by the ribs and breastbone. The pelvic or hip bones give support from below. The lower portion of the front of this container is formed chiefly of muscles.

The interior or cavity of the trunk is divided transversely by a horizontal sheet of muscle called the *diaphragm,* which provides the motor power for breathing.

Above the diaphragm is the *chest cavity* containing the heart and the lungs. Below the diaphragm is the *abdominal cavity* in which the organs of digestion occupy most of the space.

The skeleton and its joints, the muscles, and the skin and subcutaneous tissue, therefore, are the parts which contribute most to give the body its form and compose the chief part of its bulk. They are nevertheless the least highly organized and least essential structures of the body. Large parts of

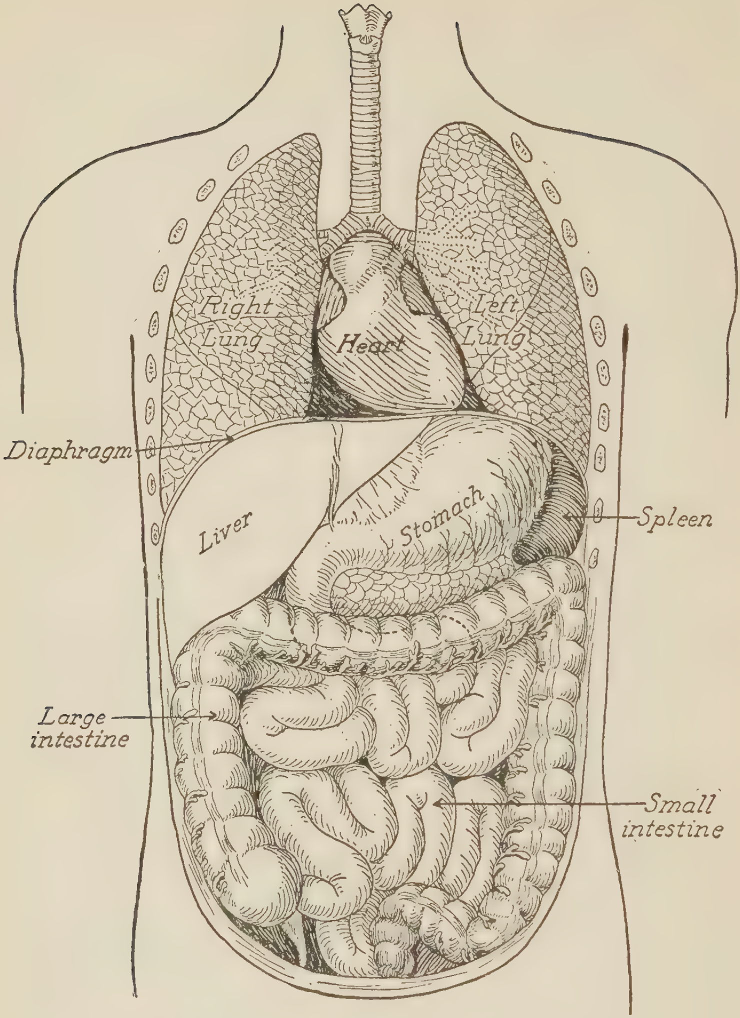

FIG. 9.—ORGANS OF THE CHEST AND ABDOMEN

all of them may be removed permanently, but, after the healing of the remaining tissues, the body as a whole will continue to live without fundamental change. Legs and arms are useful but not indispensable.

In contrast with the skeleton, the muscles, and the covering skin, the structure and functions of which are readily comprehensible from their appearance and activity, there are other organs and groups of organs with more intricate functions upon which the maintenance of life and health more largely depends. These are commonly known as the *vital organs.*

CHAPTER VI

THE INTERNAL ORGANS AND VITAL FUNCTIONS

CONSIDERED objectively, the human body is an almost automatic mechanism. Like an automobile or any other piece of automatic machinery, it functions by virtue of its ability to make special use of its supplies of fuel material. The body's absolute needs are few and simple. Given *food, water,* and *air,* it will sustain itself continuously (under any reasonable conditions of temperature) through its allotted span of life. In the last analysis it has no other absolute needs, save freedom to follow its own inclinations as to rest and sleep. Appropriate clothing and housing have enabled man to extend the range of his habitation further toward the poles, but they are otherwise unessential. Primitive man, who does not differ physically from us, exists perfectly well without them. Reduced to the simplest terms, the requirements of the human body from its environment are only air, food, and water. Moreover, the comparison with an automobile or steam engine may be carried further. The automobile is given fuel, and air with which to burn this fuel, and produces heat and mechanical power as a result of the chemical reaction between the hydrocarbon fuel and the oxygen of the air, called combustion. In the body also, life depends upon processes of combustion or oxidation, in that carbon and hydrogen in the ingested food react with oxygen obtained from the air and so produce heat and mechanical power. This combustion in the body is less violent than the explosion within the cylinders of an automobile and is far more complicated in its chemistry, but fundamentally it is similar. The mechanism of the body as a whole, however, is far more efficient and wonderful. To approach the efficiency of the human body, the automobile would have to replace its own worn tires and paint, and manage its own ordinary repairs. Thus, while the automobile is only a power plant working part time, the body may be considered as a constantly working power plant plus a self-sustained repair shop.

Such a conception of the human body, namely, that it takes in food, water, and air, causing these to combine and form carbon dioxide, water, and other waste which is discharged, so evolving heat, mechanical power, and the replacement of wear, represents only the beginning and the end of the process. A great deal lies between. All is not known to medical science, but a large part of the many intermediate processes and mechanisms by which these results are accomplished are known. The more these are understood the more remarkable they appear, and any attempt to describe them, however adequate, will fall far short of their actual wonder.

The mechanical construction or equipment of the body which controls the unceasing function of these processes is extremely complicated, but may be grouped into certain systems as follows:

1. *The Heart and Circulatory System.* The bony framework with its muscles and its covering of skin, as well as every other part of the body, is kept alive and functioning only by a constant flow of blood through it, which is maintained by the heart and circulatory system.

2. *The Lungs and Respiratory System.* Man can live only in air, since oxygen is constantly necessary; this oxygen is absorbed by the lungs and respiratory system.

3. *The Digestive System.* Food and water are as necessary to the body as is fuel to the automobile; these are received, chemically prepared, freed from waste, and then absorbed or disposed of through the digestive system.

4. *The Kidneys and Urinary System.* Waste must be discharged; the secretion and disposal of one important form

of waste is accomplished by the kidneys and urinary system.

5. *The Reproductive Systems, Male and Female.* The generation of offspring, necessary to continuation of the race, takes place through the male and female reproductive systems.

6. *The Brain and Nervous System.* Finally, life and all of its activities depend upon the brain and other parts of the nervous system.

Each of these will be discussed separately.

CHAPTER VII

THE HEART AND CIRCULATORY SYSTEM

EVERY reader is undoubtedly aware that life is dependent upon the heart. Consciousness, or the state of being aware of anything, is a function of the brain, but continued activity of the heart is necessary to maintain it and all other processes of life. Cessation of the heartbeat for more than a minute or two is practically synonymous with death. The heart may be considered as the organ most vital to existence. The reason for this is that the heartbeat and the flow of blood which it produces are necessary to the maintenance of each one of life's processes in every part of the body.

A description of the circulation of the blood and of the heart and the blood-vessels may be fairly simple or exceedingly complicated according to the amount of detail included. To revert to the simplest mechanical analogy, the heart and blood-vessels resemble the pump and water circulation of an automobile, in that they serve as a series of fluid-containing tubes through which the blood flows in a continuous circuit. The heart is a force pump which causes the blood to flow into branching tubes called *arteries,* leading to all parts of the body. These arteries finally branch into a network of tiny tubes much finer than a hair called *capillaries,* which carry their minute streams of blood into close contact with each separate body cell. These fine capillaries then reunite to form *veins* which return the blood to the heart. Thus, in the circulation of blood, the heart is constantly pumping blood through the tubes of all parts of the body, and the blood is returning to the heart to repeat its circuit. But to complete this cursory sketch of the circulation so that its function will be adequately understood, it should be added that there are actually two circulations or circuits through which the blood passes alternately. The heart contains two separate pumping chambers which lie side by side but are independent pumps. One of these, called the *right ventricle,* forces blood through the lungs, after which this blood returns to the other pump known as the *left ventricle.* This left ventricle pumps the blood to all parts of the body other than the lungs, and from these various parts of the body the blood is returned to the right ventricle, to repeat this double course. Thus, the process of circulation includes two routes, each having a specific purpose. In the first circuit through the lungs the blood gathers oxygen; in the second it conveys and delivers oxygen. Thus, by the circulation of the blood, first through the lungs and then through the remainder of the body, the oxygen necessary to all processes of life is collected and distributed.

The circulation has other duties which will be mentioned later. However, one that should be noted here concerns the absorption of food substances and water from the organs of digestion, which is performed through a special arrangement of blood-vessels. The flow of blood through the organs of the abdomen is a part of the circulation from the left ventricle, and is accomplished in a way similar to that of the other branches of the circulation, but it does not return directly to the heart. The capillaries of the intestines unite to form a large vein and this vein, instead of proceeding to the heart, leads to the liver, where it breaks up again into fine capillary channels. It is only after this second subdivision that the blood is collected and mixed with that returning from other parts of the body to enter the right ventricle. The reasons for this arrangement will be readily understood when the processes of digestion or absorption are discussed.

Thus, it will be observed that the anatomical arrangement of the circulation is such as to render it a distributing and equalizing system embracing several functions: (1) to supply

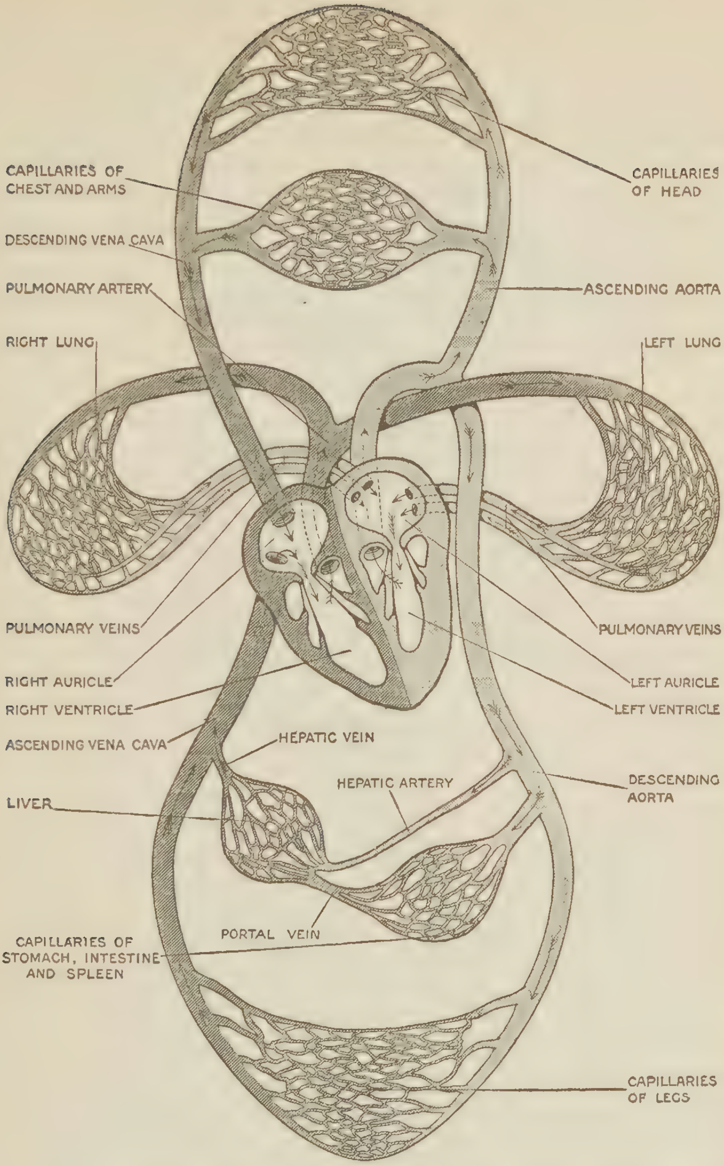

FIG. 10.—DIAGRAM OF THE DIVISIONS OF THE CIRCULATION OF THE BLOOD

From Ritchie, *Human Physiology*; copyright, 1920, by World Book Company, Yonkers-on-Hudson, New York.

oxygen and nutriment to all parts of the body; (2) to absorb waste products wherever they are formed and transport them to the organs through which they are discharged; and (3) to equalize the temperature of all parts of the body, keeping the extremities warm and preventing overheating of the structures that generate heat, namely, the heart and the muscles.

It is necessary, however, to supplement such a general outline by certain additional descriptions.

THE HEART

The heart is an organ situated in the chest, a little toward the left side, and is the pump or motor mechanism that drives the circulation in an involuntary succession of throbs, about seventy to the minute. It is constantly in action. In excitement or during exertion its rate is faster and its action more violent, but these changes occur automatically and are not subject to conscious control. The throbs or beats produce sounds which may be heard by listening to the front of the chest. Each beat is accompanied by two dull thuds, recurring with each successive beat, that sound like the syllables "lub-dup."

Anatomically, the heart is a bluntly pointed, rather conical or strawberry-shaped organ, somewhat smaller than the two fists placed together. It lies close to the front of the chest, behind the breastbone, partly hanging downward from the blood-vessels that enter and leave it by the upward end or base, and partly resting on the diaphragm below it. Its smaller end or apex points downward toward the left, and lies in the position where the heartbeat is felt most readily, nearly as far outward as the left nipple. Except where the blood-vessels enter and leave its base, the heart has a smooth glistening surface and lies free in a space known as the *pericardial cavity* which is lined by a smooth well-lubricated membrane called the *pericardium.*

It is best, however, to consider how the heart performs its

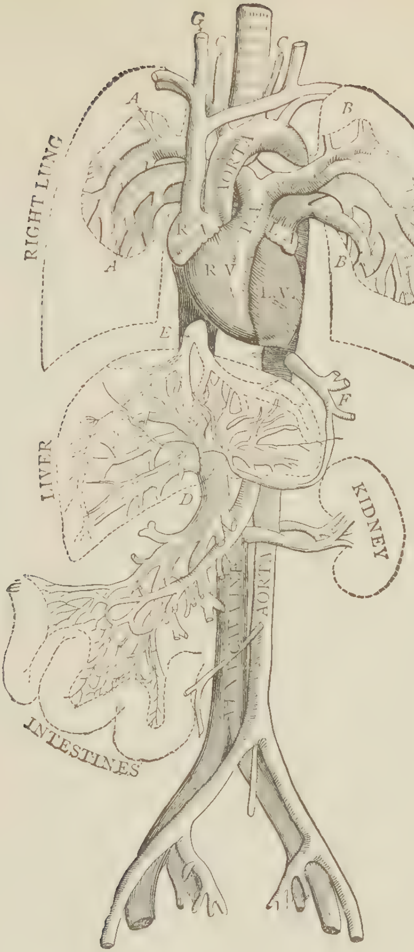

FIG. 11.—DIAGRAM OF THE CIRCULATION OF THE BLOOD

R.A., right auricle; *L.A.*, left auricle; *R.V.*, right ventricle; *L.V.*, left ventricle; *P.A.*, pulmonary artery; *A*, pulmonary artery and vein of right lung; *B*, pulmonary artery and vein of left lung; *C*, carotid artery to head, showing branch of left subclavian artery; *D*, portal vein; *E*, hepatic vein; *F*, hepatic artery; *G*, jugular vein, bringing blood from head and neck. From Hough and Sedgwick, *The Human Mechanism*; by permission of Ginn & Company, publishers.

functions, rather than to think of it in terms of exact anatomy, for its structure is rather confusing. Actually, the heart is a double pump working on the same principle as any mechanical pump. Within it there are two blood-containing cavities or chambers known as the ventricles, right and left respectively. Each of these chambers has two valves, one of entrance and the other of exit. The heart surrounding these chambers is a mass of muscle which alternately compresses and releases these chambers or ventricles. With each contraction or beat the ventricles are made smaller, the valves of entrance close, the valves of exit open, and blood is forced out through the arteries. With relaxation, the valves of exit close to prevent back-flow, the valves of entrance open, and the relaxed ventricle is filled with a new supply of blood to be pumped onward by the next beat. The two sounds that are heard with each beat are similar to those produced by a mechanical pump, the first sound representing the onset of the pumping stroke with closure of the valve of inlet, and the second the sudden closure of the valves of exit when the pumping force is relaxed. Thus, the heart operates like two pumps with reciprocal function placed side by side in a single organ.

The valves of the heart are thin fibrous flaps so constructed as to close the circular openings which they guard. They open and close passively according to the direction of the blood current. The valve of entrance of the left ventricle is known as the *mitral valve* and the corresponding valve of exit as the *aortic valve*. These will be discussed in greater detail subsequently. The corresponding valves of the right venticle, known as the *tricuspid* and the *pulmonic* valves, are less subject to disease.

Above each of the valves of entrance to the two ventricles lie the two thin-walled, distensible sacs called the *auricles,* right and left respectively. These serve as receiving chambers for the blood arriving by the veins, and it is from them that the blood enters the ventricles between beats. The walls of the auricles are composed of heart muscle which contracts at the proper time to fill the ventricles.

While the action of the valves in this pumping mechanism is simple and passive, the muscular action which provides the driving force is more complicated. It is, moreover, of peculiar interest in the study of nature's arrangements, since the heartbeat is the most automatic of any of the mechanisms of the body. Practically the entire heart is composed of a special variety of muscular cells differing from all other muscular cells of the body, and having the peculiar property of originating their own stimulus to contraction without depending upon impulses from the nervous system. This power to originate contractions is most highly developed in certain cells lying close to the mouth of the large vein which enters the right

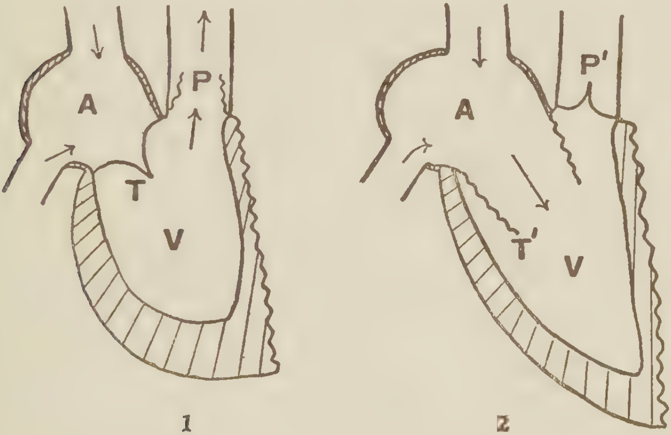

FIG. 12.—DIAGRAM OF THE RIGHT HALF OF THE HEART, ILLUSTRATING THE ACTION OF ITS VALVES

1, contraction or systole, forcing the blood into the pulmonary artery. 2, relaxation or diastole, the cavities of the heart filling with blood from the veins, while the pulmonic valve prevents back-flow from the artery. *P*, pulmonic valve open as blood is forced into the pulmonary artery. P^1, pulmonic valve closed, preventing back-flow from the artery. *T*, tricuspid valve closed, preventing back-flow into the auricle. T^1, tricuspid valve open, permitting blood to enter and fill the ventricle.

auricle from above. Under normal conditions each heartbeat begins spontaneously in these cells and spreads in a rapid wave over both auricles. Then the impulse to contraction passes through a connecting band of muscle, known from its discoverer as the *bundle of His,* to the ventricles, whose contraction occurs an instant later. So automatic is this action of the heart muscle that the hearts of animals can be made to beat for hours after they have been removed. This automatism of the heart, however, is mentioned merely as a curious fact. It is too obscure a mechanism to be thoroughly discussed in a volume such as this. The chief points to be understood are that the heart is composed of two pumping chambers with appropriate valves; that the blood of the great systemic or aortic circulation of the body enters the right side of the heart from its veins; that it is then pumped by the right ventricle to the lungs and returned by veins from the lungs, completing the pulmonary circulation to enter the left side of the heart; and that it is then pumped throughout the body by the left ventricle to repeat the aortic circulation.

THE BLOOD-VESSELS

The *arteries* are somewhat thick-walled tubes which branch continuously, becoming smaller and smaller, until they finally break up into capillaries. Their function is to conduct in different directions blood which has been pumped from the heart.

The *pulmonary artery* is the large trunk through which the right ventricle forces blood to the lungs. Passing upward from the base of the heart it divides into two branches, one for each lung.

The *aorta,* through which the left ventricle discharges its blood, is a more complicated structure owing to its diverse course. Springing from the left ventricle it first rises upward; then it forms an arch backward and descends, slightly in front of and along the left side of the spine, throughout the length of the chest and abdomen to the loins where it divides into two branches, each of which leads to the leg on its respective side. Throughout this course it gives off other branches. Two large branch arteries continue upward, one through each side of the neck, to the head. Two pass outward, one through each armpit, to the arms. Below the diaphragm, several branches are given off to supply the special circulation of the digestive organs. A large artery passes to each of the two kidneys. In addition to these larger arteries there are many smaller ones springing directly from the aorta, and the subdivisions of all of these are innumerable.

The *coronary arteries* are two rather small but extremely important vessels springing from the aorta just as it leaves the heart and supplying blood to the walls of the heart itself. A continuous blood supply through these arteries is necessary to continuation of the heartbeat.

The *capillaries* into which the arteries finally break up are so small that they can be studied only through a microscope. Their walls are so thin as to be almost invisible even with the highest magnification. The capillaries, therefore, may be considered as an infinite number of tiny tubules through which the blood passes in close contact with almost every individual body cell.

The *veins,* some of which may be seen beneath the skin of the hands, are the rather thin-walled tubes draining blood from the capillaries and returning it to the heart. In a general way the veins follow the same courses as the arteries but carry blood in the reverse direction, from the head, from the arms and legs and from the trunk, toward the heart. The largest vein of the body is known as the *inferior vena cava,* ascending through the back of the abdomen to enter the right auricle. Just before it passes upward through the diaphragm it is joined by the large vein from the liver, the *hepatic vein,* draining the circulation of the digestive system. The *superior vena cava* is the large vein which enters the right auricle conveying the blood from the head and arms. The *pulmonary veins* drain the circulation of the lungs into the left auricle.

THE PULSE AND BLOOD-PRESSURE

The *pulse,* which may be felt in any of the larger arteries that lie in such a position as to be palpable, represents the rush of blood through the artery which results from each contraction of the left ventricle. But the arteries themselves are not merely passive tubes; they have muscle fibers in their walls (of yet another variety called *smooth muscle*) which may modify the quality of the pulse. The somewhat elastic tension of the walls of the arteries and the resistance to outflow from the artery into the capillaries combine to render the arterial circulation continuous instead of intermittent, as it would be if the arteries were rigid and inelastic pipes. The flow of blood is speeded by each heartbeat, but because of the elasticity of the arteries the pressure of the ventricular contraction is not exerted all at once. The arteries stretch a little, and back-flow into the heart is prevented by the valve of outlet from the heart, thus producing substantial arterial pressure even while the ventricle is in relaxation.

The tension within the arteries, known as the *blood-pressure,* may be measured easily in a way which determines both the pressure at the height of the beat and the lower pressure between beats. Normally, the lower pressure is more than half of that at the height of the pulse wave. Thus, if arteries are accidentally severed, they bleed with a force which increases in a spurt with each pulse but which is still not wholly intermittent.

The flow in capillaries and in veins, and the bleeding from them when cut, is slower, constant, and non-pulsating.

THE BLOOD

The heart and its vessels so far described are provided solely to carry the blood throughout the body in a constant circuit.

Therefore to understand the circulation, it is necessary to know what the blood is and how it functions in this complicated arrangement. Obviously, the blood is a circulating fluid, but its special properties are extremely numerous and complex. Its function, as already suggested, is to convey various substances from place to place throughout the body. But not all the materials which it carries are capable of entering into simple solution in water. The blood transports gases, especially oxygen and carbon dioxide, in larger amounts than can be dissolved in water alone. It should be borne in mind that the absorption of oxygen and the discharge of carbon dioxide are constant needs in the chemistry of life, and the composition of the blood seems to be primarily to meet this need of conveying these substances.

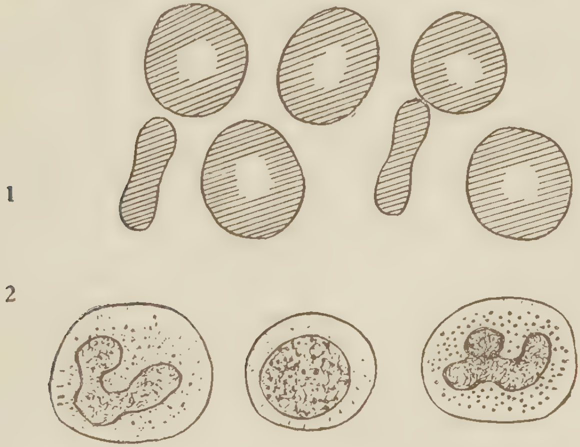

FIG. 13.—BLOOD-CORPUSCLES, RED AND WHITE

1, red corpuscles, some viewed edgewise to indicate their shape of biconcave discs. 2, white corpuscles of the three commonest types.

The blood is not a true liquid; it is a suspension of minute solid bodies, called *corpuscles,* in a liquid known as the *plasma*, or, when separated from the corpuscles by the process of clotting, as *serum.* The corpuscles are minute discs, about seven-thousandths of a millimeter in diameter, and there are about five million of them in each cubic millimeter (sixteen-thousandths of a drop) of normal blood. Each one is pale red, and it is the color of a mass of these corpuscles which gives the bright red appearance to the blood as a whole. When the corpuscles are separated from a specimen of blood, the remaining plasma or serum is a clear light straw-colored liquid.

Blood-corpuscles are formed chiefly in the marrow of the bones, and are constantly undergoing destruction and replacement throughout life. There is an organ called the *spleen,* located far back in the left upper part of the abdomen, which is concerned in the final disposition or destruction of blood-corpuscles.

The color of the corpuscles is due to a complex substance containing iron called *hemoglobin,* which has the peculiar property of absorbing oxygen when it is exposed to air, as in the lungs, and of discharging oxygen to tissues which require it. Thus, the oxygen is conveyed not by the liquid parts of the blood but by these microscopic solid corpuscles. Blood which is carrying oxygen is bright red, while that from which the oxygen has been discharged is darker with a purplish tinge. For this reason the skin of suffocating persons appears purplish or bluish.

According to recent evidence, there is reason to believe that the process of carrying carbon dioxide from the tissues where it is formed to the lungs where it is discharged is also a function of the hemoglobin.

All other materials conveyed by the blood are carried by the serum or fluid part of the blood, in simple solution. The blood-serum, more properly called the plasma in the living state, is the liquid medium in which the corpuscles are suspended. It is composed of water in which there is dissolved a large proportion of a substance similar to egg-white, together with *dextrose* or blood-sugar, and many mineral salts, chiefly sodium chloride. The blood-plasma contains many obscure substances, including the toxins and antitoxins of diseases, as will be explained subsequently.

When blood escapes from its vessels by bleeding, it becomes partially solidified like jelly. This process is called *clotting,* and consists of a binding together of the red corpuscles by a material called *fibrin,* so that they form a gummy mass which separates from the still fluid serum. Therefore, serum is plasma which has been slightly modified as the result of this clotting process. After cuts and wounds, clotting is largely instrumental in checking bleeding.

There are also microscopic bodies in the blood known as *white corpuscles,* or *leukocytes,* which are present in much smaller numbers, about one white corpuscle to every five hundred red corpuscles. They differ entirely from the red corpuscles both in form and in function, having among other properties the capacity to absorb solid particles such as bacteria. They will be discussed subsequently in connection with the reactions to disease.

THE LYMPATHIC CIRCULATION

In addition to the circulation of the blood, there is a less definitely organized movement or circulation of the watery juice of the body which is present everywhere, outside of the blood-vessels, and serves as a liquid medium to bathe the body cells, like swamp water surrounding the amœba. This watery fluid is called *lymph,* and the ill-defined vessels in which it collects and flows are called *lymphatics* or lymph channels. These probably exist in all parts of the body, although in health they are little in evidence. But when inflammations[1] occur, as of the hand, the lymphatics become inflamed and may be seen as fine red lines extending up the arm. They originate vaguely in the outlying parts of the body and flow toward the more central parts. Lymphatics lead eventually

[1] See chapter entitled Pathology, or Tissue Changes in Injury or Disease, p. 129.

to structures known as *lymph glands,* which are situated in various parts of the body, notably in the neck, in the armpits, and in the groins, as well as among the internal organs. Normally, these are about the size of beans, but when inflamed they become considerably larger. In a way, they seem to serve as filters to arrest bacteria [2] and other foreign particles carried by the lymph.

In addition to the definite lymph glands, there are, in certain parts of the body, less well-defined collections of tissue, similar in composition to that of the lymph glands, called *lymphoid tissue.* The *tonsils,* which may be seen in the throat, one at each side of the base of the tongue, are irregular masses of lymphoid tissue with rather uncertain function. The spleen also is composed chiefly of lymphoid tissue, and becomes enlarged in certain infections.

Thus the blood and the circulatory system which it fills serve together the twofold purpose of supplying all parts of the body with the substances they require, and of removing such products as are not vital to their existence. It remains to be seen how oxygen is supplied to the blood by the lungs; how the materials necessary to combine with the oxygen are derived from food and supplied to the blood by the organs of the digestive tract; and how the blood is relieved of its waste products by the kidneys.

[2] See chapter entitled Infections by Bacteria, p. 166.

CHAPTER VIII

THE LUNGS AND RESPIRATORY SYSTEM

Man can live only in air, which is a mixture of oxygen and nitrogen, not in chemical combination. Submersion in water for more than a few minutes, or the inhalation of any gas which does not contain free oxygen for a similar length of time, causes death by drowning or suffocation. Without air, life is extinguished. This again illustrates the fact that life is bound up with processes of oxidation, to support which a supply of free oxygen must constantly be absorbed by the body from the atmosphere.

THE LUNGS

The lungs, and the air passages leading to them, are the apparatus for absorption of oxygen from the air. There are two lungs, occupying the right and left sides of the chest respectively, both being covered by the ribs. From each lung there proceeds a large air tube called a *bronchus,* and the two bronchi unite in the shape of an inverted Y to form the windpipe or *trachea,* by which, in breathing, air passes in from the nose or mouth to the lungs and then out again.

The lungs are somewhat spongelike structures, in the sense that the air tubes which enter them branch continuously until they become infinitely small, ending in minute air-containing cavities. Thus the total volume of the lungs, which is quite large as they fill most of the cavity enclosed by the ribs, is composed chiefly of microscopic air spaces, into and out of which air can pass freely in the process of breathing. The walls which separate these minute air spaces are formed of extremely thin tissue; on a microscopic cross section of a lung, they appear to be like the joints of a mosaic or of an irregularly laid tile flooring. Thin as these walls are, however, they contain minute capillary blood-vessels. Thus, a microscopic cross section of lung tissue shows essentially a network of fine blood-vessels surrounding air spaces.

The purpose of this construction is not difficult to understand. The reader will probably have recognized that it facilitates a mechanism by which the air in the air spaces and the circulating blood in its capillaries are brought almost into contact with each other over a large surface area. The blood is retained within these microscopic vessels, but as it flows it is separated from the air space by a tissue of such slight thickness as to be almost imperceptible even when viewed through a microscope to which a thousandth of a millimeter is readily appreciable. Thus, this almost infinitely thin tissue which separates the air from the blood can prevent the escape of the blood from its vessels, at the same time permitting of the absorption of oxygen by the blood. Therefore, the blood circulating through the lungs (by the process already described under Circulation) is constantly absorbing from the air the oxygen necessary for the life of the body.

This, however, is only one purpose of the lungs. In addition to the intake of oxygen they likewise accomplish the expulsion of that important waste product, carbon dioxide gas, and also of considerable water vapor. The exchange of gases between the air in the air spaces of the lungs and the blood circulating in the walls of these spaces is a "two-way" process, oxygen entering the blood from the air, and carbon dioxide passing out into the air from the blood. Thus, when a number of persons have remained for some time in a small poorly ventilated room, the air becomes "close." The oxygen is reduced and the carbon dioxide increased. In addition, the humidity is raised, and odors may also emanate, these representing the excretion of other gaseous substances not of sufficient importance to mention here save as illustrative of the

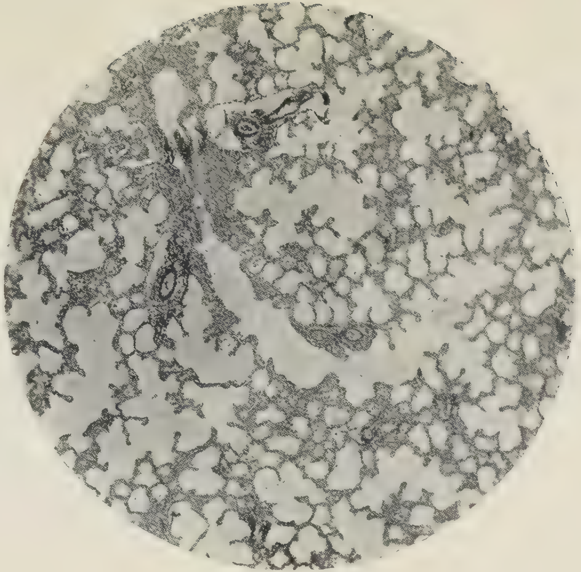

Fig. 14.—Microscopic section of normal lung

The white areas are air spaces, separated by tissues containing the capillaries.

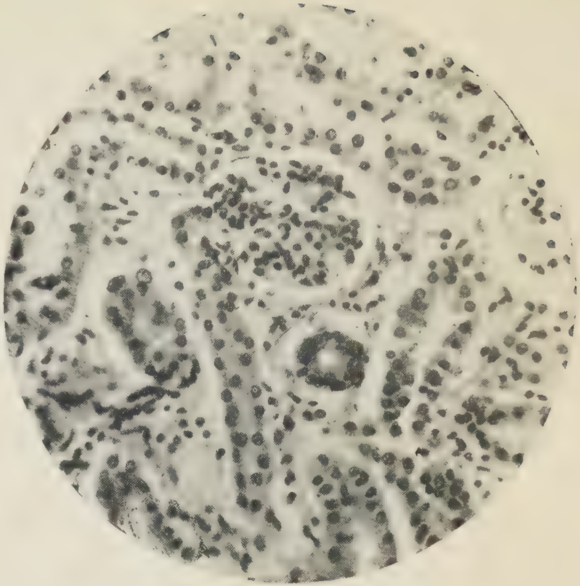

Fig. 15.—Microscopic section of kidney tissue showing glomerulus or secreting element

The bulb-shaped body is a tuft of capillaries from whose blood the urine is extracted. The straight cellular structure is a tubule which conducts the urine away.

fact that the lungs may discharge not only carbon dioxide gas and water vapor but, to some extent, other volatile gaseous waste products.

THE DIAPHRAGM

Breathing is accomplished by muscular effort, chiefly by the action of a circular sheetlike muscle called the *diaphragm* which divides the internal portions of the trunk transversely into two compartments—the chest cavity above and the abdominal cavity below. When relaxed, the diaphragm bulges upward like a dome, because of the supporting pressure of the abdomen below; but when the muscle fibers which form the diaphragm contract, the area of the whole sheetlike structure diminishes, and, by pulling against the fixed attachments of its circular margin to the ribs, its dome is drawn downward and flattened. This acts like the pull upon the piston of a suction pump or syringe, creating negative pressure or "suction" in the cavity away from which the piston or diaphragm is displaced. Thus, when the diaphragm contracts and moves downward, negative pressure or a partial vacuum is created within the chest cavity above it.

But the chest cavity as a whole is not open to the air. The lungs are suspended in it. Disregarding their exact structure, they may be compared to rubber balloons communicating with the outer air only through the trachea. Thus, when the diaphragm is drawn downward, air is "sucked" into the lungs, so that they expand; when relaxed, the diaphragm returns to its original higher position, the same amount of air being blown out again.

This movement of the diaphragm is supplemented by muscular movements of the chest and abdomen.

The lungs do not fill and empty completely with each breath, but by constant breathing the air in each little air cavity of the lungs is constantly being mixed with new air and so is kept sufficiently fresh.

THE PLEURA

While the two lungs fit exactly against the inner surface of the chest wall, they are not attached to it, being fixed to the body only at their "roots," where the air tube or bronchus of each leads from the lung upward and inward to the trachea, and where the blood-vessels pass on their way to and from the heart. Except at these attachments or roots, the lungs have a smooth, glistening, moist, and slippery surface, and the inner surface of the chest wall has a similar lining, so that as the lungs move with inflation and deflation their surfaces slip with a minimum of friction against the inside of the chest wall. The delicate membrane covering the lungs and their apposing surfaces is called the *pleura.* The arrangement may be compared with that of an automobile tire, the lung resembling the inner tube and the chest wall representing the casing.[1]

OTHER FEATURES OF THE RESPIRATORY SYSTEM

Before passing entirely from the subject of the lungs and air passages certain special points should be mentioned. Normal breathing takes place through the nose—the two nostrils. These are not simple tubes to the throat; on the contrary, they conduct the inhaled air through a complicated arrangement of chambers and side-chambers called *sinuses.* The object of this apparatus, which seems at first sight unnecessarily intricate, is probably to warm and moisten the air and to remove dust in order to protect the deeper air passages from irritation.

The organs of the sense of smell occupy the roofs of the two nasal cavities.

The connection of the air passages with the mouth as well as with the nose is apparently intended to furnish a defense against suffocation when the nose is obstructed. However, habitual mouth breathing is not healthful and should be avoided.

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[1] Inflammation of the pleura constitutes the disease known as pleurisy (see section on pleurisy in chapter entitled Diseases of the Lungs and Respiratory Tract, p. 297) in which the movements of the lungs are no longer well lubricated and frictionless, but become catchy and painful. To use again the comparison with the automobile tire, the condition in pleurisy is like the presence of gravel between the tube and the casing.

The *larynx,* or Adam's apple, located between the throat and the windpipe, is a specialized organ for the production of sound. In it there are two sharp-edged membranes, comparable with the rubber bands in certain sound-producing toys. When these are moved (by muscles) into close relation to each other, and set in vibration by the air blown out from the lungs, the voice is produced. In articulation, of course, the sound is modified by movement of the lips, teeth, tongue, and palate.

The larynx has above it a perfected arrangement by which its communication with the mouth is closed during the process of swallowing, so that food or liquid rarely "goes down the wrong way" into the air passages.

Further details could be enumerated concerning the air passages and lungs, which are known also as the *respiratory tract* or organs of respiration. In discussing diseases it will perhaps be necessary to elaborate what has been mentioned. Here, however, it is best not to obscure by minutiæ the more important fact that the breathing mechanism exists, and is planned, primarily, to supply the body with the free oxygen which it requires, and to expel from the body the carbon dioxide or combined oxygen which must be discharged.

CHAPTER IX

THE DIGESTIVE SYSTEM: FOODS, DIGESTION, AND ABSORPTION

FOODS

Obviously, food is the fuel which sustains life. Without it the body cannot continue to live any more than an automobile can run without gasoline. The digestive system is therefore provided to receive food and to prepare it for the particular uses of the body. Foods are of many kinds, but all[1] are substances which are products of other life, either animal or vegetable, illustrating the fact that all higher animal life exists only by utilizing lower forms.

It should be mentioned that many persons, particularly those inclined to dyspepsia and to introspection, display a distinctly morbid interest in the subject of foods, fixing their minds upon questions of diet to an unprofitable degree. It is likewise a curious fact that, while such individuals pay close attention to a physician's advice in regard to *what* foods they should or should not eat, they immediately lose all interest when discussion is directed to the no less important subject of *how much* they should eat. *What* to eat seems to present fascinating complexities; *how much* to eat is apparently so simple a matter that it is neglected. There are many dietary fads which have no medical significance. They are not harmful save in fostering morbid attention and solicitude, neither are they of benefit save to satisfy unwholesome fancies. Normal digestion is not aided by such constant thought and attention, and it is better to avoid the habit of experimenting with unusual diets.

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[1] Except salt.

In most normal persons, as in animals, appetite or instinctive inclination governs all eating and drinking, as well as the selection of foods. With relatively few exceptions the result is satisfactory nutrition; in fact, there is strong evidence that free choice in diet is most favorable to the best results. Even doctors, who are familiar with the more intricate scientific facts concerning foods and nutrition, seldom pay attention to theory in their own eating so long as they are well. However, in correcting overnutrition or malnutrition of various kinds, and in dealing with disorders of digestion, it is of considerable importance to understand nutrition in all its scientific aspects. Furthermore, it is a branch of knowledge which no one who desires a general acquaintance with science can afford to ignore.

It has already been demonstrated that the heat and the mechanical power generated by the body are the result of a process of slow combustion or oxidation within the body of certain substances, an important one of which is a variety of sugar contained in the blood. It has likewise been shown that the body tissues are composed largely of substances containing nitrogen which are known as *proteins*. These tissues are not fixed and indestructible, but constantly undergo a process of change in each one of their living cells, involving a balance between destruction and regeneration from new material. The body also contains fat, which is nutriment or fuel stored up for future needs. Water is an important constituent of body tissues as well as of body fluids. Moreover, the water of the body is constantly being thrown off in the sweat, in the breath, and in the urine, and must be replaced. Many mineral salts are also contained in the body, some in larger and some in only small amounts but all indispensable.

The body, therefore, requires fuel for combustion in energy production, and protein, water, and salts to sustain its tissues and fluids; and all of these must be derived from the food and drink of the diet. On chemical analysis, foods and drinks which compose the human dietary are found to contain all of them.

Water.—This requires little discussion. It is taken as simple drinking water or as flavored liquids such as clear tea, or in the form of fluids containing food substances as well, such as milk or sweetened drinks. Water also forms a part of all moist solid foods.

Foods which are recognized by common observation and by scientific study as nutritious, are found to be rich in substances belonging to the three following classes: (1) carbohydrates, that is, starches and sugars; (2) proteins or albumins, like egg-white; (3) fats and oils, such as are contained in cream, butter, and olive oil.

Carbohydrates.—It is a fact of organic chemistry that the starches and the sugars are closely related, and that starch is readily converted into sugar, especially into dextrose or grape sugar, of which glucose is the syrupy form most commonly known.

Starch is present in large amounts in all of the cereal grains and in potatoes—hence the terms wheat-starch, corn-starch, and potato-starch. It occurs in smaller amounts in most vegetables and fruits. Starch rather than sugar, bread-stuffs and cereals rather than sweets, may be regarded as the chief source of carbohydrate in a natural diet.

Sugars form an abnormally large proportion of the total of carbohydrate food consumed by modern civilized peoples, because cane sugar can be manufactured cheaply in large amounts. Aside from cane sugar, of which primitive man had little, smaller quantities of various sugars are contained in other foods, notably in fruits and vegetables. Milk contains about four per cent of milk sugar.

Proteins.—The best example of a substance purely protein, save for a little water, is egg-white or albumen. Meat juice is a substance of closely similar constitution. Meat, fish, and eggs are the foods from which most protein is derived.

Cheese is a more important source of protein among some foreign peoples than it is in this country. Milk contains about four per cent of protein. Flours and meals from the cereal grains contain protein as well as starch. Vegetables contain proteins in varying amounts; beans are largely so, potatos and bananas are partly so; the more watery vegetables and fruits have but negligible amounts.

The importance of meat in the dietary varies among different peoples. It is said to form almost the entire diet of the primitive Canadian Indians. In densely populated regions, as in China, little meat is available for general consumption, and among occidental races there are "vegetarians" who never eat meat.[2] All, however, obtain an adequate supply of protein, whether from meat or from other sources like those indicated above.

Albumins, which are chiefly protein, occur in nature as sticky fluids with the peculiar property of being soluble when raw but solidifying when heated to a certain point, as is illustrated in the boiled egg. Somewhat allied to the proteins is gelatin; this is chiefly found in soup stock and in meat jellies. It may be utilized as a source of energy production, but is not capable of serving as a protein for the purpose of sustaining tissue.

Fats.—These, including oils, comprise the third of the three chief classes of food substances. The fats and the oils are separated only because of a variation in their melting temperatures, the former being solid at ordinary room heat and the latter liquid. Butter and lard are illustrative of pure fats which liquefy only when heated; olive oil is typical of the oils which solidify only in the cold. Equal quantities of either have the same food value.

Fully as important in the diet as the fats and oils used in pure states or added in cooking are those more or less concealed forms as contained in meat, fish, eggs, cheese, nuts, olives, and, in smaller amounts, in certain vegetables. Milk contains about four per cent fat in the form of minute globules.

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[2] Vegetable proteins are somewhat less adapted to human needs than are animal proteins.

Of these three kinds of food substances, carbohydrates, proteins, and fats, the first and the last serve only as fuel, or material for combustion to provide heat and mechanical power. Moreover, the term fuel is used here in a literal sense, since complicated experiments in feeding men and animals have not only demonstrated the measurements of heat and power developed from them, but have definitely established the fact that the food value of any pure carbohydrate or fat is exactly proportionate to the heat which would be produced if a similar quantity of that substance were burned outside of the body. Therefore, the measurement of the *fuel value* of foods is calculated by the number of heat units or *calories* [3] which would be produced if such foods were burned outside the body. As would be expected, the fats and oils represent more heat units or calories for their weight or bulk than do the carbohydrates.

These foods, which have the primary purpose of serving as fuel to be oxidized in the body processes, have a secondary use. If they are taken into the body in larger quantity than is consumed as fuel, the remaining excess is stored in the body as fat. And it should be understood that body fat is formed not only by the simple deposit of ingested fats and oils; carbohydrates and proteins eaten in excess of the body needs may also produce increase of fat. Excessive development of fat, known as obesity, is merely the ultimate result of the ingestion of food with fuel value in excess of that expended in the body processes. There is some evidence that fat is somewhat more readily deposited from fatty foods than from carbohydrates, but on the whole there are only two fundamental factors involved: (1) the total calories of the diet; (2) the total of heat production and bodily activity.[4]

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[3] In physics the calorie is the unit of heat, and may be defined as the amount of heat necessary to raise the temperature of one cubic centimeter of water one degree Centigrade.

Proteins also contribute to the total caloric value of the diet, but in addition they have a special use which no other food substances can supply. They maintain the particular nutrition of the many different tissues. As demonstrated, the body is composed of myriads of microscopic cells of many different kinds but all of a common origin. Regardless of their variety, these cells are composed of protoplasm which in its chemistry is largely protein. With certain exceptions, such as the fat tissues and the bones, in which the cells are merely envelopes for fat or lie in deposits of lime salts respectively, and fibrous connective tissue like the leathery layer of the skin, the body is composed chiefly of various forms of protein protoplasm.

Moreover, the living cells of the body are in a process of continuous change. Their protoplasm is consumed, the nitrogen from their protein being finally passed out of the body, for the most part as urea in the urine. Therefore a daily supply of new protein must enter the body in the diet.

As stated, the amounts of carbohydrates, protein, and fat required in a satisfactory diet are usually determined with sufficient accuracy by the appetite. More scientifically, however, the requirements are as follows: (1) the total calories,[5] derived from the totals of carbohydrates, proteins, and fats should be such as to maintain the constant body weight proper for the individual; (2) the nitrogen intake in the form of protein must neither be less than the nitrogen discharged from the body nor more than a moderate amount, the exact measurement of which is somewhat variously estimated by different authorities.

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[4] For further discussion of this subject, see section on Obesity in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 334.

[5] It should perhaps be added that this total of calories must be made up in part of both carbohydrates and fats, for total lack of either affects the utilization of the other

While the necessary amount of protein is not appreciably influenced by muscular effort, the caloric requirement is greatly increased by activity which represents the expenditure of energy. Diets which are usually proper for adults of average body weights should contain the following totals of calories (carbohydrate, protein, and fat) and of protein.

Total Calories

In sedentary life—2,000 to 2,500 per day
In moderate activity—3,000 per day
In extremely hard labor—6,000 per day

Total Protein

Minimum 60 grams per day
Average 110 grams per day

By the use of tables[6] the caloric value in calories and the protein in grams of any diet may be calculated.

Cellulose (vegetable fiber).—In most of the vegetables and fruits there is a considerable proportion of a substance called cellulose, which is chemically a carbohydrate but which, in most forms, is not utilizable as a carbohydrate food by man. Horses and cows can derive nourishment from hay but man cannot. Probably some of the more tender forms of cellulose, as in uncooked lettuce and fruits and in cooked table vegetables, have some caloric value for man, but this certainly is very slight. It is the starches and sugars, the proteins and the fats present in these cellulose-containing, vegetable foods that give them the nutritive value they possess, the cellulose adding only to the bulk. In potatoes, sweet fruits, beans, nuts, and olives the nutritive value may be considerable, but of most vegetables very large quantities must be eaten to provide either many calories or much protein.

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[6] Edwin A. Locke, M.D., *Food Values* (D. Appleton & Co., 1920) is recommended as both reliable and conveniently arranged.

Vitamins.—It has long been known that individuals deprived of fresh foods contract the disease known as scurvy, and that scurvy may be prevented or cured if lime juice, orange juice, or tomato juice is given to such persons. More recently, other diseases and abnormal conditions have been traced to diets lacking other forms of food. It has therefore been concluded that in some foods, as in orange juice, there must be certain substances without which the body cannot thrive. Although as yet there is little exact knowledge of the nature or chemical composition of the substances thus assumed to exist, they have been named *vitamins*. Of these there are at least three kinds: (1) that already mentioned, which seems to be present in fruit juices, in vegetables, and in fresh milk; (2) that[7] apparently present in the outer coatings and germs of cereal grains, which are removable in certain refining processes, such as the polishing of rice; (3) that apparently an ingredient of cod-liver oil and other animal fats, as well as of meats and vegetables, and serving to accomplish the beneficial effects of ultraviolet light.

In recent years there has been much discussion about these vitamins, and many persons have quickly concluded that, since small amounts are necessary, the larger the amount of vitamins they can eat the healthier they will be. This is entirely unestablished. It is probable that there is little if any advantage in taking large amounts of vitamins and that those present in all usual diets are ordinarily adequate.

Salts.—Of many salts of mineral elements, sodium chloride or ordinary table salt is the most common, but there are many others, notably those containing calcium, phosphorus, iodine, and iron, which are indispensable. With rare exceptions, these are fortunately supplied adequately and automatically in all ordinary diets. The intake of sodium chloride is guided by personal tastes, and although in certain diseases of the kidneys it is inadvisable to use too much salt, the amount of salt used is otherwise of no great consequence. The blood and the tissue juices all contain sodium chloride to an amount of nearly one per cent.

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[7] Ordinary yeast is rich in this vitamin.

Seasonings.—These are substances used in the preparation of foods to gratify the sense of taste, but although ingested they usually do not supply anything which must be absorbed by the body. Pepper and other spices have no food value but are used only to stimulate taste and perhaps digestion. Alcohol, as in wines and liquors, has no important food value but is probably the most efficient stimulant to appetite. Sugar, on the other hand, is both a flavoring and a food substance of high caloric value.

INTAKE AND DIGESTION OF FOOD

Beginning at the mouth and ending at the anus is the food canal, known as the *alimentary tract*. Obviously, its purposes are: (1) to receive all food and drink; (2) to provide a mechanism by which the body as a whole can absorb what it needs from such food and drink; (3) to discharge unutilizable waste.

Although this canal passes through the body, it is better for explanatory purposes to regard substances which are in the canal as not actually incorporated in the body, but merely in contact with its inner surface surrounding the canal. Thus foods are of no benefit, nor can most poisons do any harm, until they are absorbed by the body from this internal canal which passes through it.

Appetite, or more frequently habit, creates a desire for food and drink usually three times a day. Appetite is difficult of analysis, but it is probably a stimulus based upon the needs of the body which are appreciated in some obscure way by the nervous system. The senses of taste and smell, and even the sight or thought of food serve to some extent as spurs to appetite. Intense emotional states, as well as bodily or mental fatigue, may temporarily affect appetite.

Liquids pass directly from the mouth to the stomach by the act of swallowing, which is effected by contraction of the muscles about the throat, forcing material into the *esophagus,* the tube which passes from the throat through the chest to the stomach.

Solids are subjected in the mouth to the process of chewing or mastication. This serves to break up all solid pieces, more or less completely according to the care exercised in chewing, and the food is simultaneously mixed with saliva which moistens and softens it. The saliva has a feeble digestive action upon starches but this is practically of no importance. The chewing and mixing of food with saliva is only a preparatory step in the mechanics of digestion. This preparation, however, is important. It is true that a strong and stable digestion can proceed perfectly well with but little preliminary mastication. The solid proteins can be dissolved, and the starches and fats also

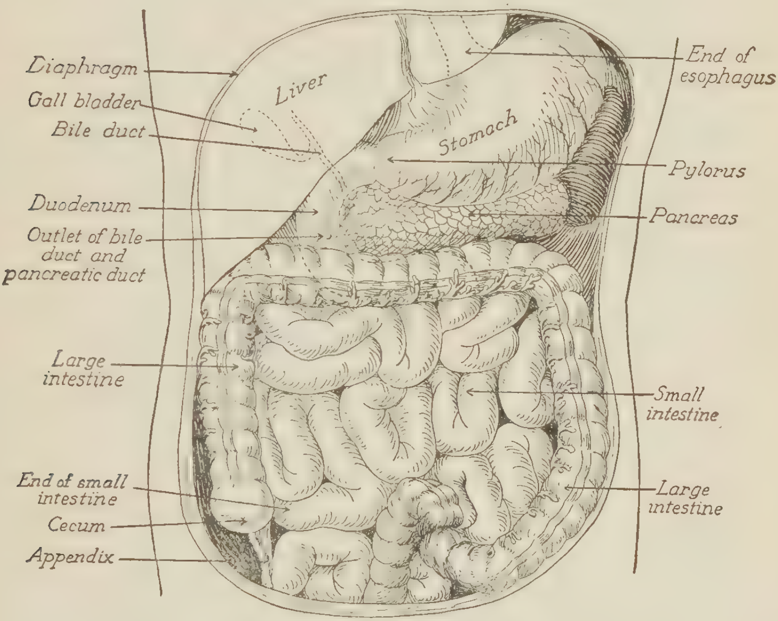

FIG. 16.—DIAGRAM OF THE ABDOMINAL ORGANS

appropriated. But human digestion, even when excellent, has little power to attack the vegetable fiber which binds all solid vegetable foods. This is a difficulty which should be recognized. Thus, if mastication is neglected, the pieces of vegetable food pass through the digestive tract undivided, and the harder forms can be softened, if at all, only by slow decomposition far down in the intestine. In human digestion, nature seems to have planned that mastication should remove all solids (save meat) and reduce food to an almost liquid pulp before it is swallowed. Thorough chewing certainly favors digestion.

Aside from the mechanical value of mastication, it stimulates the sense of taste which accompanies it. This is of more importance than is usually supposed. The taste of food is generally considered merely as a source of incidental pleasure, and occasionally as a means of detecting and rejecting foods that are disliked. Physiologically, however, the sense of taste, which is a neural mechanism, provides the signal for the stomach to pour out its digestive juices. This secretion, in response to the sense of taste, begins before any food reaches the stomach. Moreover, it is in part due to the taste or flavor of various foods that they "agree" or "disagree" with different individuals.

Milk is a food which requires separate mention because of its peculiar properties. When in the mouth it is liquid, but in the stomach it becomes partly a solid, through the familiar process of curd formation. Milk is usually considered a natural and simple food-drink, but a little reflection will serve to show that this view is not wholly sound. Human milk is, of course, the natural food of infants and is an extremely valuable form of nourishment at all ages. But only as cattle were domesticated by man did milk become a drink for adults, to be taken from cups. Thus, when a tumbler of milk is swallowed in a few gulps, the process is by no means a natural one. When milk is taken rapidly large curds are formed, and, although a normal digestion will dissolve them, they frequently overtax a weak digestion. All persons likely to be upset by milk should take it only in sips.

The Stomach.—The stomach is really the starting point of the digestive processes, the passage of food and drink through the mouth being only a preliminary which, save for mastication and for the signal sent to the stomach by means of the sense of taste, requires no exact description. The stomach is first a receiving chamber. It is convenient to eat about three times a day instead of more frequently. Therefore, the stomach is provided to receive a supply of food at certain intervals, to be stored and subjected to certain chemical processes while the individual turns to other affairs.

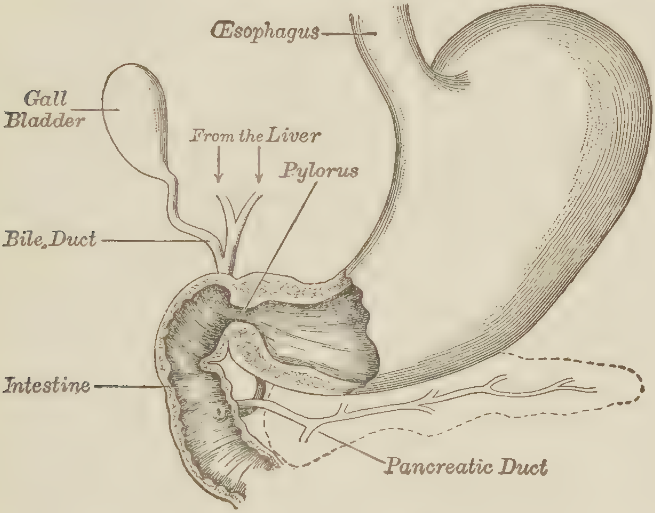

FIG. 17.—STOMACH, BEGINNING OF SMALL INTESTINE, AND ENTRANCE OF BILE AND PANCREATIC DUCTS

During digestion the bile flows directly from the liver into the intestine; at other times the opening of the bile-duct is closed, and the bile passes into the gall-bladder, where it is stored. From Hough and Sedgwick, *The Human Mechanism,* by permission of Ginn & Company, publishers.

In form, the stomach is a curved, cylindrical or cornucopia-shaped bag with two openings, readily illustrated by a diagram.

Its upper end is the larger and has the form of a rounded dome which lies against the under surface of the diaphragm somewhat to the left of the mid-line of the body. This upper end is covered in front by the lower ribs. From the inner side of this dome and a little from behind, about in the median line of the body, the esophagus enters. From its large-domed upper end, the stomach extends for a distance nearly straight downward, behind the front wall of the abdomen a little to the left. At about the level of the navel it turns inward across the mid-line and then a little upward to the right and backward, becoming, from the time it begins to curve, gradually smaller and more cylindrical. Finally, the lower end of the stomach, which lies deep beneath the edge of the ribs several inches to the right and below the end of the breastbone, leads into a tube called the *duodenum* which is the beginning of the intestine. At the narrow, lower end of the stomach, where it joins the duodenum, there is a circular band or ring of muscle fibers called the *pylorus,* and when this band contracts it closes the outlet of the stomach. It appears as if a string were tied about it. This peculiar-shaped, two-ended bag known as the stomach has rather flabby, thin walls composed largely of muscle fibers, so that it may expand to a variable size. Moreover, during digestion, the muscular coat constantly undergoes slow wavelike contractions and relaxations which slowly churn its contents and urge them toward the outlet or pylorus. The stomach has an inner lining of *mucous membrane,* which is the general term applied to the moist surface coatings of the internal passages of the body, corresponding to the skin. Unlike other tissues of the body, this lining of the stomach is immune to the solvent action of the digestive fluid.

In addition to the esophagus above and duodenum below, the stomach is attached structurally to the rest of the body only along its shorter concave margin, by a fibrous sheet of tissue which binds it loosely to the structures in front of the spinal column. Elsewhere, its outer surface is covered completely by a smooth moist membrane called the *peritoneum,* the purpose of which is similar to that of the pleura of the lungs and the pericardium of the heart. Thus the stomach is free to move within the abdominal cavity save at its attached concave edge. The entire abdominal cavity and the other organs contained therein, such as the intestines, have this same moist, slippery surface membrane which permits of almost frictionless movement within the abdominal or peritoneal cavity, such movement of the organs being limited only by partial attachments.

In the fasting state, the stomach is small and practically empty of any fluid or solid contents, but it does not collapse completely as it always contains some air. When food or drink enters the stomach, its muscular coat automatically relaxes so that the contents received are accommodated, up to a certain limit, without any increase of internal pressure. The total capacity of the relaxed stomach is about three pints. The air which is present in the stomach before food enters remains there, floating above the horizontal level of the fluid contents. If, however, by any departure from normal, there is increased pressure within the stomach, some of this air is expelled by belching, a mechanism resembling that of a safety valve. There is much popular misconception about belching. Many people have the mistaken notion that the air raised by belching is a gas produced by fermentation. This is not true save in one extremely rare condition. Chemical tests of the gaseous contents of the stomach show them to be merely atmospheric air with only negligible amounts of other gases. At the conclusion of a meal, therefore, the stomach contains masticated solids mixed with such liquids as have been ingested. These naturally gravitate to its lowest portion, while the uppermost part contains such air as is present.

From the membrane which lines the stomach there is now secreted the fluid known as *gastric juice,* which has remarkable chemical properties. It is composed of hydrochloric acid (about 0.2 per cent) together with a less analyzable substance known as *pepsin.* These two, in combined solution, can convert insoluble solid proteins into soluble products. If a bit of the white of a hard-boiled egg is placed in gastric juice, or in a solution of hydrochloric acid and pepsin artifically prepared, and is kept at body temperature for perhaps half an hour, this bit of solid protein will disappear completely by passing into solution. Hydrochloric acid alone, of the same strength, or pepsin without acid, will not dissolve egg-white in this way.

In the chemistry of digestion the most important function of the stomach is to accomplish this liquefaction of solid proteins. Thus the fibers of meat and fish, egg, milk curds and cheese, and the solid vegetable proteins as in nuts and lentils introduced into the stomach are so attacked that they become soluble substances with also a certain change in their chemical composition. This process is not confined to the stomach, since there are other provisions for subsequently completing such of the work as the stomach leaves undone; but in all normal digestion the process of liquefying the solid proteins is largely accomplished in the stomach.

Starches, sugars, and fats on the other hand do not undergo important changes in the stomach, except that their particles or droplets may be separated by the dissolving of proteins with which they are mixed.

The action of forming curds in milk should be mentioned again as a curious function of the gastric juice. Except in relation to milk, however, there is no curd formation.

Water, when taken alone, passes out of the stomach rapidly, but food remains in the stomach for a longer period, being discharged through the pyloric outlet slowly, in a series of intermittent spurts. The pylorus, which controls the outlet, has a complicated mechanism by which only some of the wavelike motions of the stomach are able to cause jets of its contents to pass through into the duodenum. Thus, after a meal, emptying the stomach is a gradual process accomplished in from one to several hours. While some solids can be passed on, the mechanism is better adapted to liquids or semiliquids.

The Intestine.—When these spurts of contents from the stomach enter the beginning of the intestine, they are mixed with other digestive juices, and then the mixture passes onward through the long coiled tube which forms the remainder of the alimentary tract. Along this course two procedures are accomplished: (1) The contents, which up to this time have been affected only by the stomach, continue to undergo further chemical changes, in preparation for their absorption, which constitute intestinal digestion; (2) substances required by the body which have been prepared by this digestion are absorbed through the walls of the intestine from its contents, and enter the blood which carries them to all parts of the body. These processes take place most actively in the upper portions of the intestine.

The intestine begins with the duodenum, which is continuous with the stomach. The duodenum roughly resembles three sides of a square, each side being only a few inches in length. For nearly the whole of its bent course it is fixed immovably against the upper portion of the posterior wall of the abdominal cavity, a little to the right of the median line. The duodenum empties into the remainder of a tube known as the *small intestine*[8] which is about twenty feet long and about an inch in diameter, its regular coils and folds filling a large part of the abdominal cavity. These coils are freely movable, as they are all attached only at one side of their circumference to the edge of a flexible, folded, somewhat fan-shaped sheet of tissue called the *mesentery.* Through this mesentery the blood-vessels lead to the intestine at its free edge, as if proceeding from the base of a fan to a binding attached to its margin. But the mesentery is so loose a structure, particularly at its free edge to which the small intestine is attached, that the coils of intestine may constantly change their position and arrangement with little to impede them. The free surfaces of the intestine and also of the mesentery are covered with peritoneal membrane which prevents their adhering to each other or to the walls of the peritoneal cavity with which they come in contact. Low down in the right side of the abdominal cavity the small intestine ends and the *large intestine* or *colon* begins.

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[8] While the small intestine is described as composed of duodenum, jejunum and ileum, the last two of these scarcely need to be distinguished here; for practical purposes the small intestine may be considered as a single long irregularly coiled tube.

This structure is several times wider in diameter than the small intestine and has a total length of about six feet. In form and in position it somewhat resembles a horseshoe with the ends downward, and encircles the region occupied by the small intestine; but its upper or transverse portion, instead of being arch-shaped, sags in the middle like a hammock. The vertical portions of the large intestine on the right and on the left sides are fixed almost throughout their length to the posterior walls of the abdominal cavity. The transverse portion, on the other hand, hangs at the edge of a loose sheet or mesentery in a way similar to that of the small intestine and is therefore movable. That point of the horseshoe which is low down on the right side is the beginning of the large intestine and is called the *cecum*. This is a blind pouch, as the small intestine enters it, not at its end but on its inner side, some inches above the bottom. From the bottom of the cecum, or from somewhat to the inner side and behind its lowest point, there proceeds a small blind tube known as the *appendix*, or more explicitly, the *vermiform* (worm-shaped) *appendix*. This curious little structure, for which no purpose has ever been discovered, is but a few inches long and somewhat thicker than a large earthworm. At one end it has an open, central canal leading from the cecum by which the intestinal contents are free to enter it, but the other end is closed. While the base is fixed to the cecum, the outer end extends in a direction which varies in different persons, but usually inward. This end is without lateral attachments and is covered by peritoneum, extending somewhat like a boneless finger among the coils of the small intestine. It is, of course, an inflammation originating in this appendix which constitutes the disease known as appendicitis.

The course of the large intestine from its beginning, the cecum, extends upward on the right side, then across, in a loop which may hang down even below the navel, to a position high on the left side, then downward on this side of the abdomen. Low down on the left it again becomes movable and bent in a terminal portion called the *sigmoid flexure* which extends downward and backward through the *pelvis,* to a final portion called the *rectum* and its exit called the *anus.*

The entire intestinal tract (the small and large intestine) has a lining of mucous membrane which is continuous with that of the stomach although very different from it. Particularly in the small intestine the mucous membrane has many folds and prominences, both visible and invisible to the naked eye, which increase the area of the surface that is in contact with the contents. Like the stomach, the intestine also has muscle fibers in its walls which exert wavelike contractions, having the effect of agitating its contents and of causing them to move onward. It is likewise filled in large part with gaseous contents in addition to the fluid and solid materials; but unlike the gases of the stomach those of the intestine, particularly of the large intestine, are not atmospheric air, but gases formed from fermentation and putrefaction.

Into the duodenum, just below the stomach, close to the beginning of the small intestine, lead two ducts or tubes which are the outlets for the secretions of two important organs, the *pancreas* and the *liver.* Both of these have other functions not connected with digestion, but in addition each supplies a secretion which is necessary to intestinal digestion. These secretions mix with the contents as discharged from the stomach and induce another series of digestive processes.

The pancreas is a somewhat elongated, thin organ which lies transversely across the front of the vertebral column behind the abdominal cavity, just above the level of the navel.

The liver is a large organ which lies below the dome of the diaphragm and above the stomach on the right side and extends downward to the edge of the ribs.

The secretions of the pancreas and of the liver are alkaline. Therefore one effect of their mixture with the acid contents which leave the stomach is to alkalinize their acid reaction.

The *pancreatic secretion* has a wider range of properties and is more effective than any of the other secretions in the process of digestion. It not only continues and completes the liquefaction and conversion of proteins, but it also alters the carbohydrates and the fats. By its action, all starches and all sugars other than dextrose (such as cane sugar and various fruit sugars) are converted into dextrose. Fats and oils, which remain unchanged and separate in ordinary watery fluids, are emulsified and partly saponified. Thus, by the effect of the alkaline pancreatic juice acting on the food as it passes downward from the beginning of the small intestine, all of the three chief forms of food substances, the proteins, the carbohydrates, and the fats, undergo the changes which are necessary to prepare them for absorption into the circulation.

The *bile,* which is secreted by the liver and is poured into the intestine at the same point as the pancreatic secretion, has a less striking effect. It is yellow, bitter, of alkaline reaction, and is secreted in large amounts, but its importance in digestion does not seem to be proportionate to its amount and to the size of the organ which produces it. There is some reason for the theory that the bile represents, in part, waste products to be discharged from the body, just as other waste products are discharged from the kidneys in the urine. Together with the pancreatic secretion it is effective in altering fats and oils; the alkalinity also serves to neutralize the hydrochloric acid which is secreted in such large amounts from the stomach.

The mucous membrane of the intestine also has a secretion which possesses some slight digestive power. But more important than this, particularly in the lower portion of the large intestine, is the secretion of a watery gelatinous substance called *mucus* which serves as a lubricant.

As the intestine extends, the growth of bacteria[9] in its contents becomes increasingly profuse, resulting in processes of fermentation and putrefaction similar to those which occur when foods decompose outside of the body. These processes too must be considered as a part of normal digestion since their products are absorbed and utilized by the body. Bacterial fermentation of carbohydrates and the putrefaction of proteins supplement the pancreatic digestion of such food substances as yet remain undigested before they reach the lower parts of the intestine.

Insufficient mastication is unfavorable to complete digestion by the stomach and by the pancreas and consequently it leaves more work to be done by bacterial decomposition in the large intestine. The vegetable masses which are bound together by vegetable fiber (cellulose) are particularly resistant to digestion by the stomach or by the pancreas, and are broken up, if at all, only by bacterial decomposition. It is these bacterial processes that produce the gases of the intestine. When carbohydrate fermentation is more active, the gases discharged are relatively odorless; in protein putrefaction the gases are particularly malodorous. While it may sometimes be excessive, bacterial growth in the intestines is a normal condition present in every one. The largest part of the total bulk of the waste discharged from the intestines is composed of the bodies of bacteria. It has been estimated that the average human intestinal movement contains about thirty trillion single bacteria.

The non-gaseous contents of the small intestine and of the upper portion of the large intestine are chiefly of liquid consistency, containing such solid particles as may be present in suspension. Below the middle of the large intestine, however,

[9] See chapter entitled Infections by Bacteria, p. 166.

the contents become drier, being of a consistency which varies from soft and pasty to quite hard. This is due to a final absorption of water. The muscular contractions of the intestine, which proceed coincidentally with this process of desiccation, result in the formation of small pieces. These usually fuse more or less completely in long cylindrical masses, but persistence of the subdivision into smaller segments is regarded by some authorities as representing the more complete result of intestinal function. The brown color is derived from the bile.

At last this solid material accumulates near the outlet of the intestinal tract. About once a day there is an automatic impulse to discharge it by a muscular action which is under voluntary control.

Thus a certain amount of food is ingested and a much smaller bulk of waste is discharged; and of the small quantity discharged, the larger part is composed of bacterial growth, not residue of food. The intervening processes have removed from the food almost all the proteins, the starches, and the sugars. Some fat and some soaps formed from fat remain, as well as fragments of the more woody vegetable substances, but the nutritive elements of the food have been thoroughly extracted.

ABSORPTION OF FOOD SUBSTANCES

The absorption of nutritive substances is to be distinguished from digestion proper, although the two are closely related. Digestion is the conversion of food into substances which can be absorbed. Absorption is the taking up of these final substances *from* within the digestive tract and their passage *into* the circulation. In this sense, absorption takes place almost exclusively from the intestine, the lining membranes of the mouth and the stomach being so constituted as to be unable to accomplish this. The lining membrane of the intestine, however, has the capacity to transmit the products of digestion through itself so that they can be taken up by the capillaries of the intestinal walls in a way similar to that in which oxygen enters the capillaries of the lungs. Throughout their course, the intestines receive arteries which spring from large branches of the aorta at the back of the abdominal cavity. These branching arteries extend through the mesentery to the edge along which the intestines are attached, and supply blood to the capillary circulation of the intestines which absorbs the products of digestion. Veins drain the capillaries, carrying away the blood with its newly acquired substances.

However, as mentioned in the chapter on The Heart and Circulatory System, the great trunk vein known as the *portal vein,* which is formed by the union of all of these small veins from the interior of the abdomen, does not proceed directly to the general circulation. Instead, it leads to the liver, and there it divides again into capillary channels in which its blood is subjected to other processes.

One of the most important functions of the liver is to serve as a storage place for carbohydrate fuel, or as a sort of a coal bin. In filtering through the fine blood channels of the liver, the blood containing newly absorbed dextrose (the sugar which has been formed from starches and from other sugars in the food) gives up its excess of this sugar to the cells of the liver. These cells of the liver store it away for future needs in the form of yet another substance known as *glycogen,* a variety of animal starch deposited also in the muscles. The blood then leaves the liver by the hepatic vein, soon to reenter the heart.

When the body in general requires more sugar in the blood, this process is reversed. Stored glycogen is reconverted into dextrose which enters the blood in the capillary channels of the liver and is carried into the general circulation by the hepatic vein.

The storage and utilization of the sugar absorbed from food and carried by the circulating blood to the liver, to the muscles, and to other tissues of the body apparently depend upon an obscure substance called *insulin.* It has recently become possible to prepare insulin from the pancreas of animals so that it may be provided to the human body as necessary by injection through the skin.[10]

One other mechanism of absorption should be mentioned. In addition to capillaries, there are lymph channels known as *lacteals* in the walls of the intestine. These collect the emulsion of fats from the intestinal contents and conduct it, through an unexpectedly long duct known as the *thoracic duct,* upward from the abdomen through the diaphragm, then upward through the whole length of the chest cavity to empty into the large vein which lies just under the left collar-bone. This mechanism seems to effect the absorption of most if not of all fat, and seems to concern itself with fats only. In the blood, fat is transported partly in fine droplets and partly in the form of a soluble derivative called *lecithin.* Fat is stored in the liver, in the subcutaneous tissue, and in other body tissues.

Protein products, salts, and water are absorbed through the capillaries of the intestine. But, unlike the carbohydrates, they are not deposited in the liver, nor are they stored in any other special organ of the body; they remain in the blood and are carried to all the tissues and juices of the body.

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[10] See also section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

CHAPTER X

METABOLISM AND INTERNAL SECRETIONS

It has already been demonstrated that the body is like an engine, whose power depends upon its receiving oxygen and fuel and combining these through a process of slow combustion or oxidation. It has also been shown how the oxygen, the food substances, and the water which carries them, enter the body, and how they are pumped to all parts of the body by the circulation. The further changes and combinations which they undergo in the body must next be considered. These are designated by the general term *metabolism.*

METABOLISM

The chemical processes involved are intricate but have been traced to a considerable extent. Some of the blood-sugar derived from starches and sugars in the food is oxidized in the blood and lymph, but a considerable part of it is also deposited in the muscles, as well as in the liver, in the form of a substance known as glycogen. In the process of muscular contraction this glycogen combines with oxygen through reactions of which lactic acid is one intermediate product, leading to the end products of carbon dioxide and water. The proteins play a dual rôle. Some of the protein derivatives absorbed by the blood are used to supply the vital needs of the body cells, but a larger part is converted by oxidation of its carbon and hydrogen into carbon dioxide and water, thus serving as fuel in the same manner as carbohydrate. Fat and its derivatives also undergo intricate changes before the end products of carbon dioxide and water are evolved, with the resultant liberation of energy. Apparently the utilization of fats bears some relation to that of sugar, since in carbohydrate starvation (such as sometimes occurs in the treatment of diabetes [1]) the oxidation of fat seems to be arrested, with the result that certain abnormal products accumulate in the body and produce the condition known as *acidosis*.

But it should be understood that these processes of life are not merely spontaneous reactions of chemistry, occurring automatically when the various substances are admixed. The mechanisms by which these materials for combustion are supplied may be regarded as only preparatory. To effect their combination, or their reaction upon each other through the processes involved in life, a further inciting or igniting force must be present.

To learn what this is, it is necessary to examine certain activities of the living body. When, in voluntary muscular activity, the signal [2] is given by the brain for the biceps muscle to contract, the forearm is raised. Obviously, some fraction of a foot pound of energy has been expended. The impulse transmitted by the nerve to the muscle has caused the muscle to shorten, and, as explained under the description of muscles, the shortening of the biceps muscle has caused the forearm and hand to approach the shoulder. Microscopic studies of muscles in contraction and in relaxation have revealed that the shortening of the entire muscle is probably due to a slight change in the form or arrangement of each one of the innumerable cells or fibers composing the muscle. But the fact is that a thought has been the inciting cause of the changes in all of these muscle fibers, which has resulted in the raising of matter as represented by the forearm. The impulse of the nervous system is an obscure something analogous to the electric spark in the ignition of the automobile, which sets up in muscle fibers some sudden change comparable with an explosion, resulting in the forceful contraction accompanied by the chemical changes which have been described.

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[1] See section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

[2] For a further discussion of this see chapter entitled The Nervous System and the Special Senses, p. 114.

In daily life, and still more when an athlete or a laborer is engaged in strenuous exercise or work, this same process is multiplied. Here the outward result is not a mere fraction of a foot pound of work, but many foot pounds. Heat is also produced. Not only does the worker feel warm but heat is actually demonstrable by experimental apparatus. Much more heat is radiated by the body while hard work is being done than while at rest. Thus heat as well as power has been generated. And, as it may be unnecessary to add, tests of the air inhaled and exhaled show that much more oxygen is consumed and correspondingly more carbon dioxide is given off during work than at rest. Thus the production of motion and of heat by the voluntary muscles and the oxidation process are closely related.

When such expenditure of energy is long continued under conditions of starvation, or of disease which prevents the absorption of food, the amounts of sugar in the blood and of glycogen in the liver and in the muscles become depleted and the fat deposits in the body likewise become reduced. All this makes it apparent that the work of the body is performed by processes in which the blood-sugar, glycogen, and fat derivatives form the chief fuel. But in voluntary work and, in fact, in practically all body processes except heart action, the energy-producing chemical change or metabolism apparently requires a kind of ignition from the nervous system, either directly or by the formation of stimulant substances called *hormones*.

The heart is an involuntary muscle beating continuously. As is well established, it also generates heat as well as motive power, unquestionably through the same combustion process as that which occurs in other muscular work. But, unlike the other muscles, the heart provides its own inciting influence without depending upon the nervous system. Certain muscle cells at the entrance to the right auricle have the inherent power of stimulating contraction as well as of contracting, and it is their impulses which incite contraction in all of the other heart cells.

Other movements within the body also represent the evolution of energy. These are not confined to muscular activity, as of the diaphragm in breathing or of the intestine in digestion. The chemical processes of secretion and even the obscure functioning of the brain and nervous system also represent more complex and finer manifestations of the expenditure of energy, although in unmeasurable amounts.

In addition to all of these modes of energy production, which are expressed in external motion, in work performed, or in heat produced for the benefit of the entire body, it should also be remembered that each body cell must sustain itself. Just as the independent amœba must constantly receive nourishment and discharge waste, so each cell of the human body requires individual sustenance irrespective of its coöperative duties toward the maintenance of life in the body as a whole. Here energy production is secondary, the chief object being to maintain normal nutrition of the protoplasm of the cell. To this end the protein derivatives called *amino acids* are indispensable. Under the inciting influence of the life force in the cell, these nitrogen-containing substances are accepted as the cellular food used in the process of change which constitutes the life of the cell. The resulting nitrogenous waste products of cellular life are discharged into the lymph and blood, being then carried by the blood to the liver where most of them are converted into urea which is finally excreted by the kidneys.

Thus the chemical processes or metabolism of the body may be grouped in two classes: (1) those whose object is energy production, or the performance of work and the evolution of heat[3]; and (2) those which represent maintenance of life in the individual body cells. In the first class, the oxidation of carbon and hydrogen is the chief function; in the second, nitrogen utilization repesented by the ammonia radical is the prominent factor. As mentioned in the discussion of foods, it follows from this that, when hard work is demanded, the total fuel value of the ingested food must be increased; but, irrespective of activity, a certain amount of nitrogen in the form of protein is always required and in hard work the quantity of protein need not necessarily be increased.

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[3] Muscular contraction likewise produces minute quantities of electrical energy.

"Basal" Metabolism.—The total of metabolism or oxidation is increased by work and decreased by inactivity. The minimal metabolism, which is measurable by a certain method while the body is in a state of least activity, is known as the basal metabolism. This varies in different individuals, and may be described as a measure of the rate at which internal combustion is proceeding. Testing the basal metabolic rate gives valuable information, since departures from the normal have certain unfavorable effects and may require treatment.

It has been shown that the explosion-like action of the skeletal muscles is incited by the will, and that the motor activity of the heart regulates itself according to the general bodily activity. It has likewise been demonstrated that the internal processes of body cells stimulate their own metabolism. The first of these is conditioned by physical activity; the second proceeds continuously. But there is another group of factors that influence metabolism, namely, certain substances called *internal secretions* which circulate in the blood and body fluids. One of these in particular, that of the thyroid gland, to be discussed shortly, has a profound effect upon the rate of internal combustion or basal metabolism. Depending upon the activity of this thyroid gland, and possibly upon other similar factors still unknown, some persons are overactive in all their body processes, consuming more oxygen and requiring more food to maintain their nutrition, while others are more sluggish in their physiology and tend to gain weight even though they eat but little. Abnormal variations in this respect will be discussed subsequently.[4]

INTERNAL SECRETIONS

The body metabolism, the regulation of blood-pressure and of the circulation, and a number of other important physiological processes are controlled in part by substances formed in the various glandular structures of the body and discharged from these glands into the circulation. These glandular products, which are not secreted into individual organs or excreted from the body but which, on the contrary, are discharged into the blood-stream for utilization by the body as a whole, are called internal secretions. There are a number of glands whose only apparent function is the production of internal secretions. There are others, notably the pancreas, which produce both an external and an internal secretion.

Knowledge of the internal secretions is for the most part of recent development, but the existence of a number of them is well established, and although few have been isolated in any approach to a pure state, similar substances may be extracted in fairly concentrated form from the glands of animals. The internal secretory glands of which there is knowledge, together with their respective activities, are as follows:

The Thyroid Gland.—The thyroid gland is situated at the base of the throat, and sometimes undergoes enlargement, producing a swelling known as a *goiter.* The internal secretion of the thyroid has a controlling effect in regulating the activity of most of the body processes. The results of deficient and excessive function of the thyroid gland will be discussed under diseases of the thyroid.

The Adrenal Glands.—Above each kidney is situated a small glandular structure known as the adrenal or suprarenal gland. Its internal secretion is of importance far exceeding its size.

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[4] See section on the Thyroid Gland in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 326.

This secretion has many functions, the most significant of which is perhaps that apparently directed to prevent undue relaxation of the arteries, thus maintaining normal blood-pressure. This action becomes markedly accentuated in violent excitement, such as fear or rage, when the adrenal glands discharge their secretion into the blood in large amounts, and as a result the circulation adapts itself to the needs of extreme muscular exertion. Another result is that liver glycogen is converted into dextrose so as to increase the sugar in the blood. In some respects the action of the internal secretion of the adrenals is antagonistic to that of the thyroid: hence it is extremely possible that a proper balance between the two is necessary to maintain normal conditions. In fact, it is likely that the activity and functions of the various internal secretions are not only interrelated but balance each other.

The Pituitary Gland.—Within the skull, beneath the under surface of the brain, lies a small structure known as the pituitary gland. In some respects the functions of the pituitary are allied to those of the adrenals. It has one entirely different function, however, related to the physical development of the body, which will be discussed subsequently.[5]

The Parathyroid Glands.—Immediately at each side of the thyroid are the two small structures known as the parathyroid glands, disease of which bears some relation to the convulsive disorder known as *tetany*, and also disturbs the behavior of calcium in the body chemistry.

The Pancreas.—As mentioned before, the pancreas produces an internal secretion, insulin, which is necessary to the conversion of sugar in metabolism.

The Ovaries and Testicles.—The ovaries and the testicles also have internal secretions, as is demonstrated by the fact that surgical removal of these in youth has a decided effect upon the physical development in adolescence. But our knowledge of these secretions is slight and uncertain, and current fantastic theories concerning them, whether honestly maintained or promulgated for fraudulent purposes, should be regarded with suspicion.

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[5] See section on Disorders Connected with the Pituitary Gland in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 329.

The entire subject of internal secretions is a new development in medicine which is still largely in the experimental stage, and it is necessary to restrain the imagination when drawing conclusions not supported by acceptable evidence.

CHAPTER XI

THE KIDNEYS AND URINARY SYSTEM

It has been shown how carbon dioxide is given off through the lungs. And it has likewise been demonstrated how the non-utilizable residue of food which has passed through the food canal (although it has never in the strictest sense been incorporated in the body) is discharged from the anus, and how these intestinal discharges carry with them some waste products which enter the intestine in the bile. The skin also discharges some salts and oily material as well as water.

Just as the lungs provide the remarkable mechanism for throwing off the end products of the oxidation of carbon-containing substances, so a similar provision exists in the kidneys for another important mechanism which serves to eliminate the end products of those processes that consume proteins or nitrogenous material. This mechanism for freeing and discharging nitrogenous waste products is located in the kidneys and the urinary passages, sometimes referred to as a whole under the terms *urinary system* or *urinary tract.*

The *kidneys* are two organs which lie behind the abdominal cavity, one on either side of the vertebral column at the level of the lowest ribs in the back. Each kidney is a bean-shaped body, about the size of a fist, and is placed vertically with its concave side facing inward toward the median line of the body.

From the middle of this inner or concave side of each kidney, a long tube extends downward and inward behind the abdominal cavity, almost to the lowest part of the downward extension of the abdomen known as the pelvis, where it enters the base of the bladder. These tubes are called *ureters.*

The *bladder* is a collapsible bag or a contractile receptacle which lies behind and below the bony prominence at the front of the pelvis. It has a capacity of approximately a pint, and may be emptied voluntarily from time to time through the passage known as the *urethra*. The outlet of the bladder, located at its lowest point, is kept closed by a ring-shaped band of muscle fibers which may be relaxed voluntarily to allow the urine to flow out through the urethra.

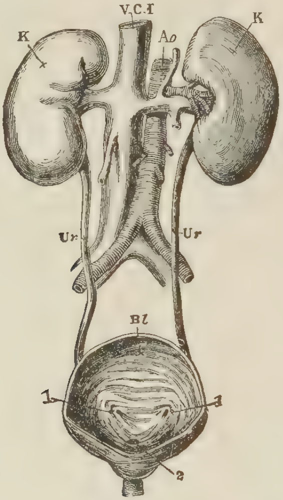

FIG. 18.—DIAGRAM OF THE KIDNEYS, URETERS, AND BLADDER

The kidneys (*K*); ureters (*Ur*); with the aorta (*Ao*); and vena cava inferior (*V.C. I*); and the renal arteries and veins. *Bl.* is the bladder, the top of which is cut off so as to show the openings of the ureters (*1,1*) and that of the urethra (*2*). From Huxley and Barcroft, *Lessons in Elementary Physiology*; courtesy of The Macmillan Company of New York and Macmillan & Company of London.

The urethra in women is short and direct. In men it is much longer, following the course of the penis and serving as a passage for the male genital fluid or semen as well as for the urine.

In the male, just behind the outlet of the bladder, between this and the front wall of the lower end of the intestinal tract, is a small organ belonging to the genital tract known as the *prostate gland.*

Large arteries lead to both kidneys and from them large veins, branches of the aorta and of the largest vein (inferior vena cava) respectively. Thus a large amount of blood is constantly being pumped through the kidneys so as to be relieved of its nitrogenous waste.

The capillary circulation of the blood through the kidney is interesting by reason of its intricacy. As studied microscopically it reveals much, both as to the normal processes and their variations in disease. But for present purposes it is sufficient to consider that the kidney, like the lungs, the intestine, and the liver, is an organ in which the fine capillary blood-vessels permit a transfer between their blood and whatever is external to their walls. In the case of the kidney, minute tufts of capillaries are surrounded by spaces into which water together with various substances in solution filter. These tiny spaces of the kidney are drained by microscopic tubules, the walls of which have a further effect upon the fluid which passes through them by removing some of the water, thus concentrating the urine. These innumerable tubules conduct the urine to a cavity on the concave side of the kidney, known as its *pelvis,* from which the ureters convey it to the bladder.

Urine is formed by the kidneys continuously, although at variable rates; and as the urine is formed it dribbles through the ureters into the bladder, there to await discharge according to convenience.

The principal solid constituent of urine is a substance called *urea,* which is a nitrogen- or ammonia-containing end product, useless to the body, derived ultimately from ingested protein. The intermediate processes of this change from food protein are complicated and by no means completely traced. They include the formation of protein derivatives which are absorbed by the body, and the transmutation of various non-absorbed nitrogenous substances of the different tissues and fluids of the body into urea which is a non-protein nitrogenous substance. It is well established, however, that if more protein is eaten more urea is excreted in the urine, and, conversely, if a smaller quantity of protein is eaten the urea excreted is less. Bodily exertion does not increase the excretion of urea. Therefore, urea does not seem to be a product of muscular activity, but rather the end result of body processes which proceed independently of exercise or of rest. The actual formation of urea seems to take place in the liver, not in the kidneys; the latter apparently only separate it from the circulating blood.

Water is, of course, the largest consituent of urine, but it serves as a vehicle or solvent rather than as a waste product. If water is taken into the body in large amounts, the kidneys excrete the excess, but ordinarily the water which passes out in urine may be regarded as the water of a washing process. Nevertheless, water is a necessity to the body. Thirst is more rapidly fatal than starvation.

Many organic waste products other than urea are carried off in the urine, such as *uric acid* formed especially by cell nuclei, but these are found in smaller amounts than urea. Many ingested abnormal substances such as drugs are excreted in the urine, either as such or in converted form. Inorganic salts, like sodium, potassium and magnesium chlorides or phosphates, are present in the urine, and they are not to be considered as excretion of unnecessary substances taken into the body, but as the natural result of continuous bodily changes which require that the products involved in these processes shall be constantly taken in and passed out. Fortunately they are ingredients of all customary diets.

The excretion of dextrose or grape sugar by the urine is an abnormal manifestation which results when too much dextrose is present in the blood. It will be discussed later in connection with diabetes.[1]

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[1] See section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

Abnormalities in the amount or composition of the urine secreted, whether deficient, excessive or modified in other ways, will likewise be discussed subsequently.[2] The normal secretion proceeds in health without attention or conscious control. Excitement often increases the amount of urine, but this is not an abnormal reaction.

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[2] See chapter entitled Diseases of the Kidneys and Urinary System, p. 337.

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CHAPTER XII

REPRODUCTION

THE process of reproduction is of such infinite complexity that no description of it can be adequate. Moreover, scientific knowledge of its details is so incomplete that thorough comprehension of its exact nature is as yet impossible. For this reason understanding must needs give way to instinctive wonder.

The subject is one of deeper mystery to most laymen, whose familiarity with its details is usually confined to a sprinkling of superficial knowledge not at all commensurate with its scientific and sociological importance. Therefore, a statement of what is definitely known may be of value.

Every adult knows that conception occurs in the female as a result of contact with the male in an act of union, usually conditioned by natural selection, which holds intense interest for all human beings within the age limits of sexual activity. The psychological relationship of sex to life is of such vital significance that it cannot be overstated. It represents for the perpetuation of the race what hunger and thirst represent for the individual. It so permeates life that it is responsible for many of the by-products of civilization. It is a force that cannot be ignored, however inconvenient may be its acceptance. It knocks insistently at the door of life, and any attempt to refuse it admission or thrust it rudely aside may be fraught with havoc to the individual. But to recognize it, and afford it proper relationship with other forces of social existence so that it will reveal truth and beauty, is to enlarge the horizon of life. It is not within the scope of this volume, however, to attempt any survey of the psychological bearings of sex which have recently received such wide and intensive discussion. Here, consideration of the subject will be largely confined to its anatomy and physiology. We shall discuss in order (1) the anatomy and functions of the male parent, (2) the anatomy and functions of the female parent, and (3) the origin, development, and birth of the infant.

MALE ORGANS OF REPRODUCTION

The male cells through which life is transmitted from the male parent to the offspring develop in the *testicles*. These are two small firm bodies contained in the double pouch known as the *scrotum* below or behind the penis. Why the testicles in mammals should occupy exposed positions on the surface of the body instead of lying in more protected places is not clear, for they are particularly subject to painful injury from various causes.

From each testicle there leads a duct or tube which passes up through the groin and then backward and downward along the side of the bladder to the prostate gland, which lies behind and below the base or outlet of the bladder. Here, each duct is joined by a blind tube or elongated sac which serves to store the secretion. These blind pouches are called the *seminal vesicles*. The ducts continue through the prostate gland and open finally into the urethra just below the closed outlet of the bladder. The secretion of the testicles, mixed with secretion of the prostate gland, is discharged into the urethra as an essential part of the sexual act, and is then carried by the urethra through the penis and deposited in the genital passage of the female.

This secretion, known as the *seminal fluid,* is viscid and somewhat turbid. On microscopic examination, each drop is seen to contain innumerable minute bodies called *spermatozoa,* each one of these being a male germ cell capable of fertilizing the female ovum. The spermatozoön is shaped like a tadpole, having a minute rounded head or body and a threadlike tail several times as long. It is endowed with independent motility which is undoubtedly utilized to produce fusion with the ovum.

Why these male cells should be present in millions when only one among them all can serve its end in fertilizing the single ovum of the female is a provision of nature the reason for which is obscure.

The *penis* is an elongated structure through which, near the under surface, the urethra passes. In generation, the penis implants the seminal fluid within the vagina of the female, so that the spermatozoa may enter the womb. To this end the penis becomes temporarily rigid in the sexual act, a change from its usual relaxed state. This takes place by means of tense filling of the blood spaces contained within it, a local circulatory response to psychic and sensory stimuli.

The actual discharge of semen is accompanied by an involuntary or reflex mechanism which causes it first to pass into the urethra from the seminal vesicles. It is then ejected through the urethra by the contraction of certain muscles which surround the urethra and which are able to compress it in the upper part of its course.

FEMALE ORGANS OF REPRODUCTION

The female cell or ovum, through which life is transmitted from the female parent to the offspring, has its origin in an organ known as the *ovary*. The ovaries, of which there are two, are structures somewhat smaller than the testicles of the male, situated in the lower part of the abdomen called the pelvis, one on each side, close to the surrounding bones. They lie above, farther back, and at each side of the bladder.

Reaching outward toward each ovary from each side of the large upper part of the uterus there are two ducts called the *fallopian tubes*. The canals of these tubes enter the central canal of the uterus, and serve the purpose of receiving the ovum from the ovary and transmitting it to the uterus.

The *womb* or *uterus* is a somewhat pear-shaped organ, rather flattened from before backward, which lies at the bottom of the pelvis, between the outlet of the bladder in front of it and the end of the intestinal tract behind it. Its smaller end points downward and backward, and the larger, rather movable end is inclined upward and forward, leaning against the upper surface of the bladder from behind. The normal uterus is about half as large as an average pear. It is firm in consistency, being composed almost entirely of muscle fibers, and its walls are elastic. Unlike the pear, it has a central canal, open at the lower or smaller end where the stem of a pear would be.

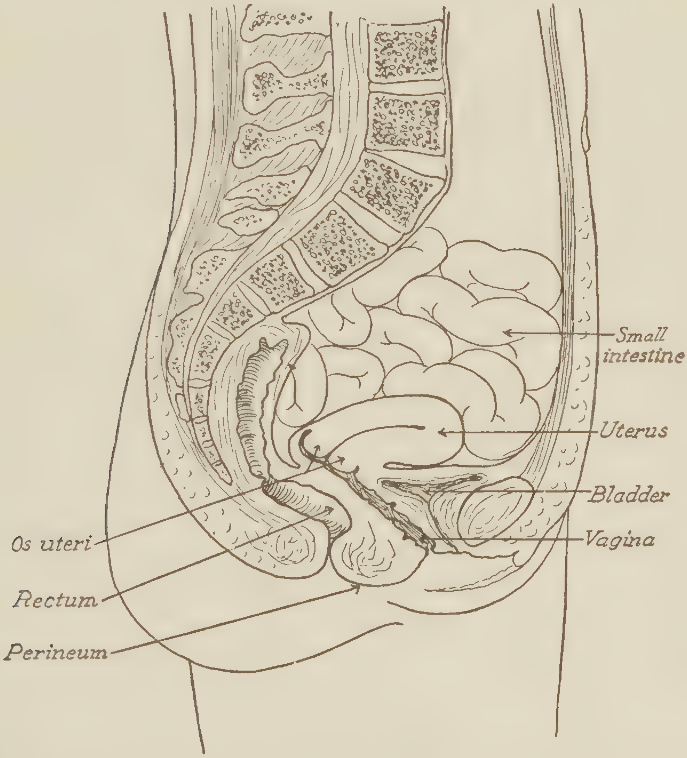

FIG. 19.—DIAGRAM OF THE FEMALE PELVIS AND ITS ORGANS

The narrow lower end of the uterus, known as the *cervix,* with its central opening called the *os uteri,* meets the large canal known as the *vagina,* which extends inward from the surface of the body just behind the urinary opening. The vagina, from its external beginning, passes backward and upward, under and behind the bladder, and reaches somewhat beyond the cervix of the uterus which joins it at approximately a right angle from its upper side.

The fleshy structure, composed chiefly of muscles, which lies between the vagina and the anus is known as the *perineum.*

The external opening of the vagina in the virgin state is partially covered by a thin membrane called the *hymen,* which is ruptured with the first intercourse, a little bleeding resulting.

In front of the urinary passage there is a small erectile structure known as the *clitoris,* the organ which receives the tactile sensations that culminate in the sexual reaction.

The ovum develops in the ovary, and one ovum is discharged from one or the other ovary about once every twenty-eight days. Connected in some way with the escape of an ovum from the ovary is the process of menstruation, which is a temporary congestion of the lining of the canal of the uterus, resulting in the passage from the uterus of a discharge containing blood. It is probable that the ovum descends at or shortly after the time of menstruation.

In leaving the ovary the ovum finds its way into the fallopian tube, and thence to the cavity of the uterus. If it does not become fertilized, it presumably disintegrates or is passed out through the vagina. If, however, during its course through the tube or while in the uterus, it becomes fertilized, by fusion with an ascending spermatozoön deposited in the vagina by the male, the fertilized ovum adheres to the wall of the central canal of the uterus. This constitutes *conception* or the beginning of pregnancy, during which the process of menstruation ceases, not to be resumed until some months after childbirth, the period varying in different individuals.

THE ORIGIN, DEVELOPMENT, AND BIRTH OF THE INFANT

Fertilization.—Human embryology, or the origin and development of man, is usually taught by tracing, as a close analogy, the development of the chick from a hen's egg. The egg of the hen is a single cell derived from the female parent which corresponds to the cell of the human female, called the ovum. As mentioned, the male parent provides a cell of only microscopic size, called the spermatozoön, which is deposited by the male during the sexual act in the genital passage of the female. Somewhere in this passage this cell enters the descending egg or ovum of the female, and becomes fused with it. In this way the egg or ovum is fertilized. Although still a single cell, it now represents the union of two cells, one from each parent, and therefore has inherent within it characteristics derived from both the father and the mother.

This fertilized cell, known in scientific language as the *zygote,* then begins to develop by a plan of spontaneous growth so intricate but so accurate that it is unparalleled in science. No one has yet been able to explain the influences which originate, nor the complex processes which effect the transformation of the ovum into the embryo, the embryo into the fetus, and the fetus into the infant, although something is known about each of these stages of development. For instance, it is known that these processes of growth occur by a series of progressive cellular divisions and redivisions from the fertilized ovum so that one brood of living microscopic cells succeeds another, and so that each cell, as it is produced, groups itself with others to mold a part of the embryo. It is likewise known that when the human embryo is finally developed and establishes itself in the womb it throws out the most complex structures to effect a union with the body of the mother by which it is to be nourished. In other words, each of these cells has within it when it is formed, a remarkable power to achieve its end in a predetermined plan of growth which is consummated by a plastic method of supreme coordination without the slightest external direction. The significance of the magnitude of this process is more readily grasped when it is remembered that, since no two human beings are alike, the activities of these cells must be subject to difficulties of one kind or another, and the plan of growth must be such as not only to overcome these when encountered, but to modify the activities of the cells whenever necessary, in order to accomplish within a given time the formation of the almost infinite number of different cells which constitute the complicated structure of the human species. Still more remarkable is the fact that from the single fertilized ovum there is a tendency to transmit to the offspring some personal peculiarities of either or both parents, or of ancestors. The form and natural characteristics of the child and of the man are thus inherent to an extent in the single cell of the fertilized ovum.

Gestation.—From the time of fertilization the mammalian ovum remains within the uterus of the female parent for a period of about nine months proceeding upon its predetermined course of development; and as the embryo grows, requiring more room, the walls of the uterus stretch until it finally occupies a large part of the abdominal cavity. After the third month of its development the embryo is known as the *fetus*. It becomes completely surrounded by a clear watery fluid which is in turn enclosed by a membrane, corresponding to the shell of an egg.

It is unlikely that the inherited characteristics of the fertilized ovum are modified during the period of gestation, although little that is definite is known about this. Diseases of the mother may unfavorably affect, or even be fatal to the unborn infant, particularly infectious diseases which may be transmitted, and the infant may likewise sustain injuries. But the more fantastic suspicions, that the personality of the offspring is affected by "prenatal influences" based upon experiences of the mother during pregnancy, have not yet been confirmed by facts and probably have their origin in superstition.

The period of gestation is apparently one in which the mother supplies the developing embryo with a protected environment at body temperature, together with nourishment and oxygen necessary for growth, the blood in its own circulation being unable to receive these from any other source. The mechanism by which this is accomplished is as follows: The fetus is attached to the wall of the uterus by a long cord which springs from its navel or umbilicus; an artery of the fetus passes through this cord to the mother, and veins return through it from the mother to the body of the fetus. The attachment of this cord to the inner uterine wall is a large flat structure several inches in diameter called the *placenta,* or the "afterbirth," since it is expelled from the uterus shortly after the infant is born. Here again there is an instance of the process mentioned in discussing the lungs, namely, the passage or absorption of substances to and from the circulating blood through thin membranes which do not permit passage of the blood as a whole. In the placenta, the blood of the fetus is brought into close contact with that of the mother, with only thin membranous walls separating the two. There is no actual mixture or interchange of blood between the mother's circulation and that of the fetus, but chemical substances are transferred freely between one and the other by absorption. From the mother's blood the fetal blood receives oxygen, food substances, and water; to the mother's blood the fetal blood transfers its waste products such as carbon dioxide and urea.

Birth.—About nine months after conception the fetus is born, the process of birth being known as *labor.* The first event is the commencement of involuntary contractions of the muscle fibers of the walls of the uterus, occurring at more or less regular intervals. These gradually increase in vigor, becoming more painful, and their exertion upon the fluid in the uterus effects a gradual stretching of the os uteri or outlet from the uterus to the vagina. This outlet becomes a ring-shaped aperture through which bulge the membrane and the fluid behind it, and after a number of hours this aperture becomes large enough to permit passage of the infant's head. The contractions then become more forceful, being supplemented by an impulse to contract the muscles of the abdominal walls while holding the breath, which institutes what is known as the "second stage of labor." About this time the membrane breaks and the fluid surrounding the fetus gushes out through the vagina. Normally, the position of the fetus in the uterus is such that its head is downward; the head is therefore the first part of the infant's body to present itself at the outlet of the uterus. In exceptional cases the buttocks are downward. This results in more difficult labor and, while in most of these instances the mother is still able to bring the child into the world by her own efforts, there is frequently advantage in, and sometimes the case demands, active assistance by the doctor. Other positions of the fetus may also occur which may render natural birth, and even surgical delivery, difficult or impossible.[1] After the outlet of the uterus is sufficiently stretched and the fluid discharged, the infant's head is gradually passed farther downward with each succeeding pain through the os uteri, through the course of the vagina, and finally out into the world. The shoulders, body, and legs follow with little delay. The passage of the infant's head through the vagina involves great stretching of the perineum[1] which frequently may be ruptured or torn in the process, thus requiring surgical repair.

About half an hour after the birth of the child the contractions of the uterus, which have ceased temporarily, are resumed, soon expelling the placenta, and this separation of the placenta from its attachment to the uterus involves some bleeding which may be serious if precautions are not taken.

Promptly after childbirth the breasts begin to secrete milk. This is another remarkable provision of nature. The breasts or *mammary glands* are composed of branching, microscopic tubes lined with special cells which produce milk from substances obtained from the blood. These minute tubes unite to form a few larger tubes by means of which the milk is discharged through the *nipples.*

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[1] See chapter entitled Obstetrics, or the Conduct of Childbirth, p. 414.

After labor is completed the uterus continues to contract, sometimes with "after-pains" of varying severity which continue for several days. It is still much larger than normally but within a week or two shrinks to its original size.

The Infant.—At birth, the circulation of the infant's blood through the umbilicus to the placenta ceases, the cord being cut and tied immediately by the physician, this last connection with the mother's body being no longer necessary. Even before this, the newborn infant has started to breathe, crying vigorously, so that its supply of oxygen from its own lungs is established. The filling of the lungs which were previously airless represents a radical change occurring automatically as the child emerges into the world. Still more remarkable is a simultaneous change which takes place in the heart in order to initiate the circulatory process in the lungs. Before birth the lungs of the fetus are practically bloodless. In the heart of the fetus there is an opening between the two auricles, so that most of the blood from both auricles enters the left ventricle. At birth, this communication between the auricles immediately closes. The right ventricle then begins to receive its full quota of blood, and to pump this through the pulmonary artery to the lungs. Thus, as the infant begins to breathe, blood is supplied to absorb the necessary oxygen into the circulation.

The initiation of the function of the alimentary tract is less prompt, but immediately after birth the infant is able to suck vigorously at the breast in an instinctive effort to obtain nourishment. Discharges from the intestines appear soon after.

The urine probably begins to be secreted promptly after birth, the first voiding occurring in the course of some hours.

From birth, through infancy and childhood, all the structures of the body increase in size, but the most striking changes occur in the bones. At birth these are relatively soft, and some bones are still ununited. Union between these eventually occurs. The long bones have separate caps at their ends, and it is between these caps and the shafts that increase in length takes place as the child grows. Lime salts are gradually deposited in the bones until they reach their final form and hardness.

THE MEANING OF REPRODUCTION

This constitutes a brief description of the physical aspects of reproduction, the essential and indispensable process in the propagation of the race. The mechanism is supplied by nature, and is automatic in its operation save in one important respect. This mutable factor is the human mind and volition.

Human reproduction differs from that of the lower animals in that, as civilized man has risen from the savage or animal state, both his intellect and his sentiments or feelings have attained a far higher plane. Love may still seem instinctive in its origin, but it is an emotion that is finer than the mere physical promptings of instinct, in proportion to the fineness of the individual. Furthermore, humanity has acquired a sense of responsibility and of right and wrong. The human intellect also contributes foresight or appreciation of consequences. The evolution of civilized society has introduced social considerations. All of these factors have formulated themselves, through the ages, into the principles of morality, and are at the basis of the sacred institution of marriage.

The function of reproduction must be comprehended in its true light. Since it is a necessity for the perpetuation of the human race, every human life that is denied a part in it is in that respect incomplete. For the physical health of the individual this deprivation may be of no consequence, but for full satisfaction in life it represents something wanting. Marriage is therefore desirable for all human beings. But in any enlightened civilization the function of reproduction must be held in veneration and must carry with it a sense of responsibility so keen and so high that it will control the intelligence and direct the emotions. Our lives are handed down to us from our parents and ancestors in trust for our children and descendants. This trust must be kept inviolate.

These matters have important bearings upon the care and training of children. All parents should understand the advantage of imparting a proper attitude toward sex to their offspring in early childhood. If such knowledge is supplied, simply, frankly, and understandingly, as the child's curiosity is aroused during the successive stages of development, there will then be little difficulty in his handling such sexual events as naturally occur in the course of life without injury to self or to others. It will make for an early and harmonious adjustment in this all-important mental sphere.

To this end, parents should have a sound knowledge of sexual hygiene, which includes sexual physiology, sexual pathology and, above all, sexual psychology. And in imparting this knowledge they must exercise sympathy and understanding. The task also requires practical vision combined with an idealism which is alike impervious to materialism and to deforming asceticism.

The periods at which sexual guidance are particularly needed are: (1) throughout early childhood, (2) at adolescence, (3) at the termination of life in the parents' home, and (4) before marriage. At these times, and at any others if the parents are not fully competent to advise, there is often advantage in obtaining assistance from the family physician.

CHAPTER XIII

THE NERVOUS SYSTEM AND THE SPECIAL SENSES

Thus far the human body has been considered from a mechanistic point of view, namely, in the light of an automatic machine which functions independently of guidance. To an extent, this is so. Certain functions which have been discussed are mechanical processes, and, although they are a direct outgrowth of the physiological and chemical environment of their structures, they proceed, nevertheless, independently. For instance, in those who have had a "stroke" or "shock" of apoplexy which has not been immediately fatal, the breathing, the heartbeat, movements of the intestine, and the excretion of urine continue even in the presence of complete unconsciousness.

THE NERVOUS SYSTEM

For practical purposes, however, life and its activities are governed by the nervous system. All voluntary actions are performed only in response to signals from the brain, and many other actions which appear to be involuntary, such as breathing during sleep, are also the result of neural impulses.

At the outset it should be understood that fundamentally the functions of the nervous system are still largely a mystery. It is therefore only possible to state what is definitely known and to suggest such deductions as seem to be plausible.

Anatomically, the gross structure of the nervous system is a complicated one extending over the entire body, but it is best described as composed of four divisions, namely: (1) the brain, a large irregular mass of white and grayish, pulpy substance, the appearance of which does not give the faintest indication or suggestion of its capabilities; (2) the spinal cord, a long structure approximately as thick as the little finger, extending from the brain through a canal enclosed in the backbone or vertebral column to the lower part of the back; (3) the peripheral nerves, which are tough, stringlike structures leading either from the brain or from the spinal cord to all parts of the body, branching continuously until their final

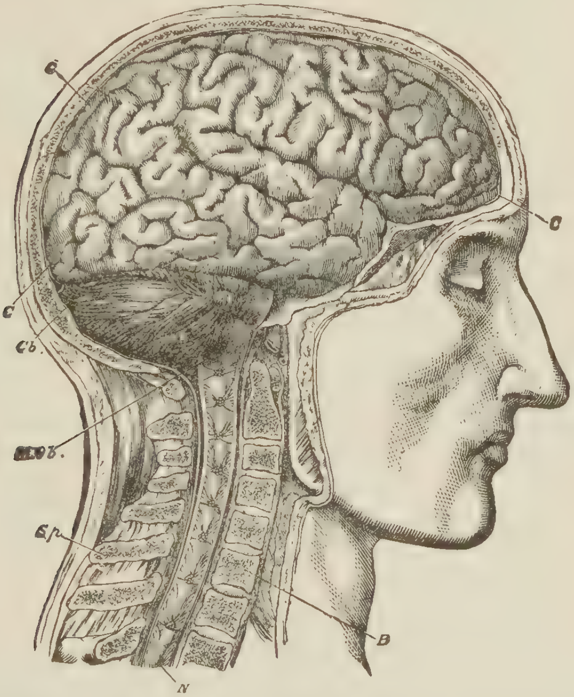

FIG. 20.—SIDE VIEW OF THE BRAIN AND UPPER PART OF THE SPINAL CORD IN PLACE, THE PARTS WHICH COVER THE CEREBROSPINAL CENTERS BEING REMOVED

C,C, the convoluted surface of the right cerebral hemisphere; *Cb.,* the cerebellum; *M.Ob.,* the medulla oblongata; *B,* the bodies of the cervical vertebræ; *Sp,* their spines; *N,* the spinal cord with the spinal nerves. From Huxley and Barcroft, *Lessons in Elementary Physiology*; courtesy of The Macmillan Company of New York and Macmillan & Company of London.

fibers are microscopic; (4) the sympathetic system, which forms a network connecting with the peripheral nerves in certain parts of the body.

For an understanding of such knowledge as is available regarding the nervous system it is likewise important to have

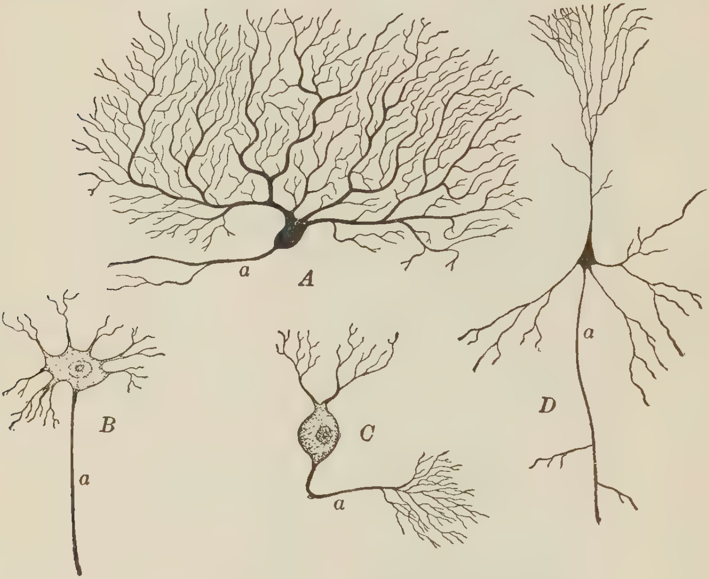

FIG. 21.—FOUR NERVE CELLS

A and *C*, from the cerebellum; *B*, from the gray matter of the spinal cord; *D*, from the cerebrum; *a*, the axon. The cells *A* and *D* are stained so that the main body and the dendrites are a uniform black; *B* and *C* are stained so as to show the nucleus and the cytoplasm. From Hough and Sedgwick, *The Human Mechanism*, by permission of Ginn & Company, publishers.

some knowledge of its microscopic structure. Like all other tissue, the nervous system is composed of innumerable microscopic cells, but the nerve-cell, unlike that of simpler structures such as the outer layer of the skin, has a highly specialized form. The body or central portion of a nerve-cell, with its so-called nucleus, a structure common to all cells, does not vary markedly from that of other cells; its peculiar feature is that it has at least two threadlike fibers extending from its main body in different directions. It is generally believed that these two tenuous, threadlike extensions have separate functions; one to carry impulses received by it *to* the body of the cell, the other to convey impulses *from* the body of the cell to the termination of this tiny fiber.

These threadlike structures may be extremely long. For instance, the peripheral nerves which extend to the tips of the fingers are composed only of such minute fibers, derived from nerve cell bodies which lie in or close to the spinal cord. The trunks of the peripheral nerves, therefore, whether they are as thick as a pencil or so fine as to be almost invisible, are composed of many nerve fibers bound together. They resemble a telephone cable containing numerous individual wires.

Peripheral nerves are of two kinds, sensory and motor. In some large nerve trunks the sensory and motor portions follow the same course for a distance, but ultimately they separate. As their names indicate, these two types of nerves serve entirely different purposes. The sensory nerves transmit sensation or feelings toward the brain or spinal cord; the motor nerves conduct impulses from the brain and spinal cord to muscles.

The neural functions are readily illustrated. If the nerve behind the elbow (the "funny bone") is cut, the skin in the region of the little finger becomes numb and incapable of feeling. It may be pricked or burned but no sensation will be perceptible. This is because the fibers along which sensory impulses travel, in their course from the little finger to the brain, have been divided at the elbow. Similarly, if a certain motor nerve trunk which passes along the outer aspect of the upper arm to the muscles at the back of the forearm is cut or crushed, the result is complete inability to bend the wrist backward, a condition known as *wrist-drop*. This is because the motor impulses transmitted from the brain are unable to reach the muscles of the forearm, the motor nerve fibers being divided.

Thus, it is clear that any sensation is the result of a mysterious something which passes through the nerve from the point where it originates to the central nervous system. It is also clear that when a muscle contracts something is conveyed through the motor nerve from the brain to the muscle. This something is perhaps closely comparable with an electric current, although it differs from it. Impulses in nerves may be induced in other ways than by the normal stimuli. If electricity is applied to the trunk of a motor nerve, the muscles to which that nerve leads will contract involuntarily. It is also a curious fact that, when a person has suffered amputation of a limb, tickling or other sensations may be experienced which seem to emanate from the absent foot. This must represent some form of stimulation in the course of what remains of the sensory nerve.

The peripheral nerves, therefore, transmit what are known as sensory and motor impulses. Their fibers are long extensions of nerve cells situated nearer to the larger structures of the nervous system. Thus, these impulses must be those which are conducted to and from the nerve cells, whatever may be their ultimate course or origin. It is probable that each sensory incoming or afferent impulse is conveyed by the cell body to its outgoing or efferent fibers, and that each motor impulse so transmitted has been received by the cell through its sensory fibers.

There are motor responses in which sensory impulses received from a certain structure of the body are translated almost directly into action of the same part, suggesting that the cell receiving the sensory impulse has at once conveyed by its outgoing fiber an impulse to the cell which supplies the motor nerve.[1] In these actions it seems possible that only a single pair of cells (or set of cells) is involved, the cell receiving the long sensory fiber directly stimulating another nearby cell to transmit an impulse along the motor fiber, without involving any action of the brain or of the more central parts of the nervous system. Such a direct reaction may be simply illustrated. If, while sitting, one knee is crossed over the other and the elevated knee tapped sharply just below the kneecap, the muscles of the thigh will contract, causing the foot to jerk forward. The tap has produced a sensory impulse which has ascended to cells at the root of the sensory nerve in the back, and this impulse has been conveyed to cells with long motor fibers in the same region. Thus, direct motion has resulted from sensation without involving any voluntary action. There is another familiar illustration of such voluntary or reflex action as the direct result of sensation which is slightly more complex. If a cinder strikes the eye, the eyelid is instantly closed. This sensory impulse undoubtedly follows a more indirect course than that of the knee-jerk, but clearly the motor result is too prompt to be caused by a voluntary neural response. It is also classified as a reflex.

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[1] No single nerve-cell has more than one fiber sufficiently long to enter a peripheral nerve. The fibers of sensory nerves lead to cells with only short outgoing fibers, and the fibers of motor nerves come only from cells with short receiving fibers. Thus no one cell alone can translate sensation into action; at least two cells are required.

STRUCTURE OF BRAIN AND SPINAL CORD

The brain and the spinal cord are composed of nerve-cells and fibers in an extremely complicated arrangement. Much study has been devoted to the mapping out of cell groups and to the tracing of their fibers; as a result, many groups of cells and sets of fibers (called tracts) have been identified and named. To a lesser extent, the functions of these cell groups and tracts of fibers have been established. For instance, it is known that the impulse for voluntary movement of the muscles of either half of the body is conveyed by nerve-cells of the brain which lie under the temple opposite to that in which the movement occurs. Thus, disease of the brain in the region of the right temple causes paralysis of the left half of the body, while disease in the left temporal region causes paralysis of the right half of the body. The cells that produce articulation, in right-handed persons, are near the motor cells in the left side of the brain which govern the muscles of the right half of the body. Thus, when a stroke of apoplexy has impaired the left temporal region of the brain, there is paralysis of the right side of the body, and, in addition, the power of speech may be lost—a condition known as *aphasia*.

The courses of the motor fibers from the temporal region of the brain through its substance and down the spinal cord to cells at the roots of the peripheral nerves have been accurately determined. As to the higher functions of the brain, however, little is known beyond conjecture. The exact seat of the process of thought by which perception is translated into action is still unknown. By analogy, it may be inferred that all thought represents the transmission of impulses from nerve-cell to nerve-cell in the brain in a complex course of endless succession. Such a theory would account for the faculties of memory and judgment in the light of past experience, on the assumption that impulses conveyed through cells are capable of creating enduring effects upon them, or upon the connections between them, thus influencing the course of subsequent impulses. This assumption would imply that motor action is determined, not only by present perceptions, but also by those received in the immediate or remote past.

Under this purely biological theory, human perception, thought, decision, and action are, in the last analysis, automatic, or predetermined by the structure of the brain and by past and present external circumstances which react upon it. Such a conception presupposes that the individual brain is a tangle of cells and fibers which has taken form, as the body developed from the fertilized ovum, according to the structure of the human brain, its more minute characteristics being determined by heredity. From birth, this sensitive structure has been the recipient of sensory impulses through the special senses of sight, hearing, touch, smell, and taste; for it is only through these senses that sensory stimuli reach the brain. Thus, the biologist concludes that all thought and behavior are ultimately the result of sensory impulses acting through the brain, and that when an action is clearly not the immediate result of present perceptions, it is attributable to past perceptions stored in the brain. Habits are explained on the theory that neural impulses tend to follow beaten paths. The more complex perceptions, such as those received by language, either heard or read, are likewise to be attributed to association between auditory and visual perceptions and those received through other senses, both during present and in past experience.

Other authorities are unwilling to accept this apparently mechanical conception. They maintain that there are factors in the processes involved in thought, judgment, will, and emotion to which this theory cannot apply. For our purposes, however, it is scarcely profitable to enter into a further discussion of the subject. The simple reflexes, it seems clear, are sensations converted into motion through the normal functioning of normally arranged cells. Whether, in determining the more complex responses of behavior, other factors enter which are not based on perceptions or on the arrangement of cells cannot now be affirmed or denied, although the biological theory seems to be gaining ascendancy.

However disputed their mechanism, processes of the mind may be classified as conscious and subconscious. The former is more easily recognized. It converts conscious perceptions and known facts into conscious and rational conclusions and decisions. The latter follows similar courses independently of any conscious attention; that is, unrealized trains of thought proceed without any conscious knowledge, influencing emotions, and even actions, unknowingly and to an uncertain degree. In recent years this field has been intensively developed and popularized to such an extent that it has resulted in many fantastic and exaggerated opinions. Nevertheless, in any analysis of behavior a consideration of subconscious trends of thought is important.

In addition to determining voluntary motor actions, and also speech which in its final analysis is a specialized form of voluntary motor response, the brain exercises control over certain unconscious and involuntary functions of the body.

The continuance of breathing during sleep has been mentioned. Another action of similar mechanism is the rapid breathing which occurs after exertion. Apparently, any accumulation of carbon dioxide in the blood in larger than normal amounts has a direct effect in stimulating nerve-cells which lie in the *medulla oblongata,* a specialized structure located at the upper extremity of the spinal cord as it joins the brain. The result is a transmission of impulses by the nerves to the muscles of respiration, so that breathing becomes deeper and more rapid.

Another similar mechanism is related to the heart and circulation. While the heart is fundamentally automatic, the nervous system exercises control over it. Impulses from the nervous system affect the heartbeat, rendering it slow or fast according to circumstances. The nervous system also exercises control over the blood-vessels so as to maintain the normal blood-pressure. Ordinary fainting is believed to be a temporary relaxation of this nervous control with a consequent drop in blood-pressure. Blushing in response to embarrassment is another illustration of subjection of the circulation to nervous influences.

There are many other unconscious mechanisms of the nervous system, some occurring through the sympathetic system, which apparently conducts neural impulses in various obscure directions, not so readily traceable as are the courses of ordinary motor and sensory impulses. The sympathetic system serves, at least in part, to regulate and to maintain proper coordination between certain of the vital processes which have been studied.

THE SPECIAL SENSES

The special senses are particular adaptations of sensory peripheral nerves. Of these, the senses of touch, taste, and smell may be passed without comment, since sight and hearing are so much more important and complicated.

Both the eye and the ear are the seat of the terminations of sensory nerves specially adapted to perceive light and sound, respectively, together with appropriate apparatus to transmit the light or sound to the nerve.

The *eyeball* is curiously like a photographic camera. At the back the spread-out endings of the sensory nerve-fibers form a sheet, called the *retina,* which corresponds to the photographic plate. Near the front there is a *lens* and a movable diaphragm. The latter is the blue or brown part of the eye called the *iris,* which contracts, making the pupil small in strong light and enlarged in dim light. There is also provision for focusing the lens under unconscious nerve control for near and for far vision. The light from any object seen is thrown as an inverted image upon the retina, which transmits the perception of it by the *optic nerve* to the brain. The eyeball is protected in front by the *lid,* and is directed by voluntary muscles which regulate its movement in different directions, upward, downward, or to either side.

The *ear* may be compared with the transmitter of a telephone. There is at the deep or inner end of its outward opening or canal a thin membrane called the *drum.* This membrane vibrates as the sound waves of the air strike it, and these vibrations are transmitted through an inner air chamber (which communicates with the cavity of the nose and is called the *middle ear*) by three little bones. Internally, these vibrations are received by a set of nerve endings within the bone of the skull which lies internal to the middle ear. The perception of sound is conducted by a nerve which passes through this bone to the brain.

This outline may be sufficient to demonstrate how it is known: (1) that the nervous system receives sensory impulses from the outer world, including those most important special sensory impulses received by the eye and the ear; and (2) that, in addition to receiving impulses, the brain also conducts motor impulses producing action, including articulation. It may also serve to demonstrate how a sensory perception is translated into a motor action in the simpler mechanisms known as the reflexes. The more complex processes which take place between perception and action, such as conscious thought and decision, are still to be discovered.

CHAPTER XIV

SUMMARY OF ANATOMY AND PHYSIOLOGY

In the foregoing description of anatomy and physiology many details have been included to serve as a preliminary groundwork to the subsequent discussions of diseases. Readers who have followed the previous chapters will therefore have a fairly comprehensive knowledge of the structure and functions of the body which may well be used for ready reference in special connections. For recapitulation and emphasis, however, the following summary may be of value.

The body is constructed upon a jointed bony frame, the skeleton, and the complicated muscular system is provided to maintain in position or to move the movable parts of the skeleton.

The entire structure is enveloped by the skin, which serves as a covering and, through perspiration, keeps the body temperature equable.

The blood, pumped by the heart, circulates within its vessels which are distributed throughout the body. This circulation has three functions: (1) to maintain an almost equal temperature in all parts of the body; (2) to bring to all structures the substances they may require; and (3) to carry away waste for disposal.

Since all vital processes are based upon chemical changes, the most important of which involve oxidation, the body requires oxygen. This is obtained from the air in the lungs by the blood which circulates through them. The lungs likewise discharge from the body all used up oxygen in the form of carbon dioxide.

Water, oxidizable material, and material used in other changes within the body, are vitally necessary. These are ingested as food and drink and are absorbed by the circulation through the walls of the intestines. What is not absorbed is thrown off by the intestine as waste, after passing through the digestive tract.

The exact processes by which the oxygen combines with food substances to produce heat and power are still but little known. Some apparently proceed continuously. Others, notably the voluntary muscular movements, occur only as the result of an obscure inciting influence from the nervous system.

Nitrogenous and other waste products are freed from the blood by the kidneys and are discharged as urine.

Reproduction is effected by union of the female cell (the ovum) with the male cell (the spermatozoön). This single, combined cell develops in the uterus and forms the body of the offspring. When the infant is sufficiently developed to live independently it is born.

The nervous system is composed of innumerable nerve cells, each one of which has incoming (afferent) and outgoing (efferent) fibers. The peripheral nerves, which extend to all parts of the body, are composed only of fibers, and are of two varieties, classified according to the particular type of their fibers. Sensory nerves, composed of incoming fibers, convey sensations to the central nervous system. These sensations include the special perceptions of sight and hearing. Motor nerves, composed of outgoing fibers, transmit the motor impulses from the brain or spinal cord to the muscles.

From such information as is available it is reasoned that all action of the nervous system, even conscious thought, may have as its basis the transmission of neural impulses from cell to cell in endless succession through their respective incoming and outgoing fibers. However, the exact nature of this neural impulse, which is the central secret of life, is still a mystery.

CHAPTER XV

PATHOLOGY, OR TISSUE CHANGES IN INJURY OR DISEASE

Thus far, attention has been directed to normal anatomy and physiology, that is, to the structure and functions of the body in its healthy state. The body, however, is subject to many and various structural alterations, and to abnormalities of its physiological and chemical processes, which constitute disease, and which produce the symptoms or abnormal sensations or disabilities perceived by the patient. The subject which treats of these structural and functional changes is known as pathology; and, inasmuch as its elucidation has usually been confined to medical writings, it is not as familiar to the laity as are the subjects of normal anatomy and physiology. But its thorough understanding is necessary for any comprehensive knowledge of the essential nature of disease.

NATURE'S PROCESS OF REPAIR

When the body was created or evolved, certain definite provisions were made against disease. Some of these are so bound up with its structure and functions that they are usually overlooked. For instance, the unbroken skin protects the body from infection by bacteria, which may enter even by a pin-prick causing inflammation; and if the eyelids did not wink upon the approach of foreign bodies, the eye would be susceptible to many more injuries than it is. Of greater interest, however, are those reactions to repair damage and to combat disease, which are provided when the body sustains injuries, or becomes subjected to the more complex changes incidental to disease. The skin may be cut, scraped, burned, or destroyed by chemicals; deeper tissues may be crushed or torn; bones may be broken. These are simple and more obvious forms of impairment or destruction of tissue, which may well be considered before the more complicated disorders that occur in disease.

In the former, natural processes of repair are spontaneously induced whenever and wherever necessary. These may require assistance by dressings, by stitches, or by splints, any or all of which may aid them to proceed as they should, but the repair depends fundamentally upon the natural processes which are almost as wonderful as the origin and growth of the body.

Infection, to be discussed later, is the chief obstacle to natural repair. If infection is avoided, and the affected part is protected against injury to the young tissue in course of formation, the repair will proceed steadily to completion, either filling the space created by what was lost, or covering it.

The formation of new tissue to replace that destroyed is essentially the same in most structures. Exceptions are surface membranes, like the outer layer of the skin, in which the procedure is simpler. In healing of the skin, there is a growth of new cells from the edges of the remaining sound skin to replace what was destroyed, which advances inward over the surface of the wound as ice forms from the margin of a pond. In any loss of deeper tissues, however, the reparative mechanism is more complicated.

When a wound is inflicted, microscopic study of its surrounding tissues soon reveals the formation of new cells. These cells are produced by a spontaneous multiplication, with a resultant change in form, of the connective tissue cells of the region. At first they are round, but they gradually become elongated, tough fibers finally forming about them similar to those of the leathery layer (connective tissue) of the skin. Simultaneously, new capillaries are formed, branching from the original blood-vessels, which serve to nourish the new tissue both during and after its appearance. The result

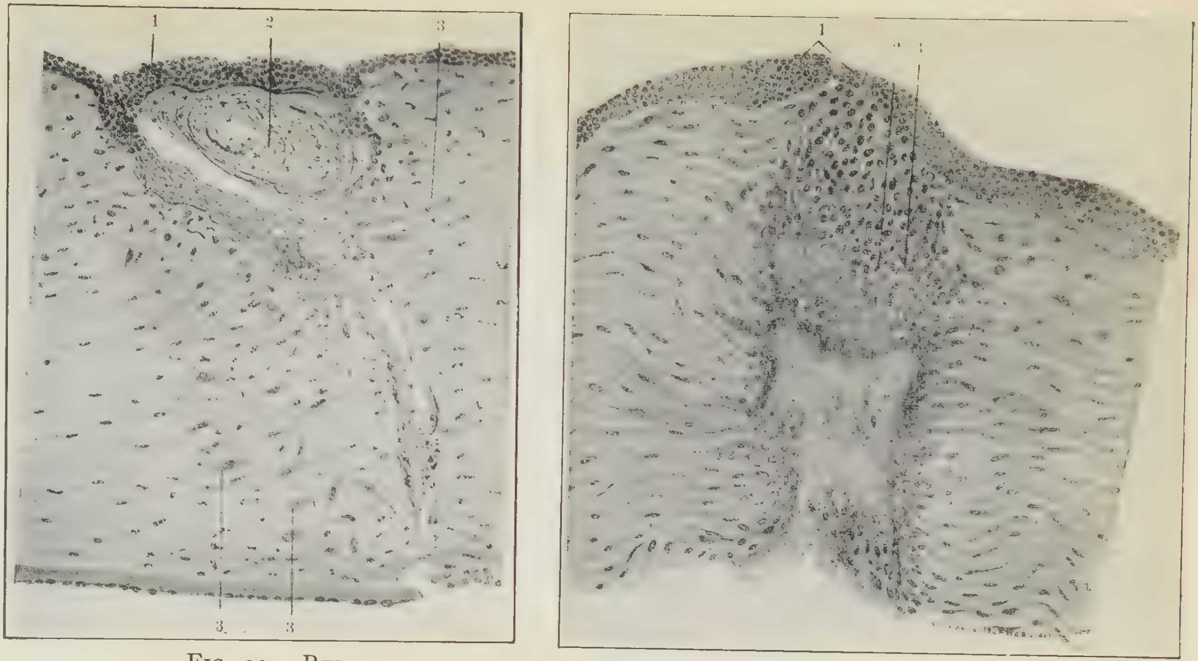

FIG. 22.—REPAIR OF AN INCISED WOUND OF THE CORNEA OF THE EYE

The cornea being without blood-vessels, the connective tissue cells can be seen unobscured by capillaries and blood-corpuscles.

Left, condition after two days. 1, newly formed epithelium growing across the line of incision; 2, line of incision filled with exudate, leukocytes and fibrin; 3,3,3, early stages of newly formed corneal connective tissue cells.

Right, condition after six days. 1, new epithelium covering in the incision; 2, remnant of exudate; 3, newly formed connective tissue derived from corneal corpuscles.

Note the general increase in cells. From Bryant and Buck, *American Practice of Surgery,* 1906 edition; copyright by William Wood & Company.

is *scar tissue*—a tough, fibrous substance of great binding strength. Particularly in its early stages, this process of repair by scar formation is accompanied by some inflammation, to be described later.

In fractures, the first step in repair is similar to that in soft tissues, but here an additional subsequent change occurs, that is, the final deposit of lime salts to form new bone—usually in a mass called *callus* which is thicker than the original bone.

Some tissue, such as muscle fiber or the cellular tissue of organs, does not renew itself after an injury. The destroyed portion of a muscle or of an internal organ is merely replaced by scar tissue. But severed peripheral nerve-fibers, which lose their power to transmit impulses when impaired, may grow together in the course of months provided the cut ends remain in contact. When this occurs their function is restored.

Thus, a more or less perfect process of repair heals all injuries that do not prove fatal.

INFLAMMATION

A more complex procedure occurs where the tissue is not frankly destroyed, as by cutting or burning, but where the affected part is subjected to slighter injury to the local tissues from which they may recover, if nature's curative forces prove adequate, without any impairment of structure or function. This is the general process of inflammation, which proceeds more or less similarly in response to a wide variety of causes. As mentioned, some degree of inflammation is an accompaniment of all injuries. But its occurrence in connection with bacterial infections is of greatest significance.

Inflammation may be regarded as a local mustering of the natural forces of the body to combat an invader. If this natural reaction is successful, the inflammation subsides and the tissues become normal.

It may be of assistance to an understanding of medical terminology to know that the ending *-itis* means *inflammation* *of.* The first syllables of a word ending in *-itis* are derived from the name (usually the Greek name) of the part inflamed. Thus, *dactylitis* means inflammation of a finger; *gastritis,* inflammation of the stomach; *dermatitis,* inflammation of the skin. It should be noted, however, that such terms are applicable only in their general connotation. Inflammations are of various types and result from numerous causes. Dermatitis, for instance, includes many varieties of inflammation of the skin.

In general, inflammation is classified according to the degree of its intensity. It may be of two kinds: (1) that in which pus formation does not develop; and (2) that in which it does, this latter type involving destruction of tissue. Pus formation is also known as *suppuration,* or *suppurative* or *purulent inflammation.* Ordinary sunburn (*dermatitis calorica*) is an illustration of the first or milder variety. Other illustrations of non-suppurative, external inflammations are scalds from boiling liquids, and the disease known as *erysipelas.* This latter is a bacterial infection of the skin causing redness and swelling but subsiding without pus formation. A pimple or boil is an example of pus-forming or suppurative inflammation. More serious instances are abscesses and other extensive pus formations in deeper structures of the body.

When visible, simple inflammation has four particular characteristics: (1) redness, (2) heat, (3) swelling, and (4) tenderness or pain on pressure.

Microscopic study reveals the reason for these changes, and gives additional evidence as to the process. The small blood-vessels appear abnormally dilated and engorged with blood, which produces the redness and heat; the tissue between the blood-vessels contains an increased quantity of its normal fluid, apparently because some has oozed from the blood-vessels, which results in swelling or thickening; pain or tenderness is probably produced by pressure of the swollen tissue upon sensory nerve fibers. In all but the slightest inflammations, however, there is another change which the microscope alone reveals; the tissues involved become more or less thickly invaded by white blood-corpuscles which have migrated from the bloodstream through the walls of the blood-vessels into the tissues.

If the inflammation does not develop further, by reason of elimination of its cause, there is a gradual subsidence of all of these changes, with subsequent reëstablishment of the normal condition. But in the more intense inflammations, whether slight as in the pimple or more severe as in a large abscess, another change occurs. The white blood-corpuscles, also known as *leukocytes,* increasingly multiply; and during the crucial period of the encounter between the invader and these leukocytes some body tissue is destroyed and liquefied, the resulting space becoming filled with a thick fluid suspension of leukocytes. This creamy liquid composed of the microscopic bodies of white corpuscles suspended in fluid is called *pus.*

It is generally true that healing or recovery cannot occur until all pus is discharged or removed. Even if one drop of pus remains, inflammation may continue indefinitely. In large abscesses, retained pus not only prevents local healing but may also produce systemic poisoning which may prove fatal. Pus in the skin, as in boils, discharges spontaneously. Deeper abscesses may find a way to discharge themselves, but as a rule they require surgical drainage, the surgeon cutting an opening through which the pus may escape. When a large abscess remains undrained, death usually results.

In addition to typical acute inflammation of the two types described, another variety known as *chronic inflammation* deserves separate mention, since it follows a more sluggish course. In this category the changes due to tuberculosis in various parts of the body are by far the most important, but a number of rarer diseases occur, the effects of which may also be classified as chronic inflammation. These processes are less intense than are those of acute inflammations and suppurations, developing more gradually and usually with less pain, but they are in general similar. Where visible, redness and heat appear less marked, and pain and tenderness may be absent; swelling, however, is apt to be pronounced. Pus may collect but this is exceptional. In chronic inflammations the formation of fibrous scar tissue similar to that which repairs wounds is more in evidence than in most acute inflammatory processes.

DISEASES INVOLVING INFLAMMATION

The importance of processes which may be classified as inflammatory is best comprehended from the following enumeration of significant diseases all of which are essentially inflammations. These are due to various infections, the meaning of which will be further explained. But despite the differences in causation and in the area of involvement, the reactions of the body to these causes, represented by the particular manifestations of disease, are more or less similar.

When inflammation occurs in parts of the body which are susceptible to examination, it will be observed that there are redness, heat, and swelling, and there may be pain. Some internal inflammations, however, are painless because the region is not traversed by sensory nerves. As mentioned, in all inflammations, regardless of their site or intensity, there is distention and engorgement of blood-vessels, increase of fluid in the tissues, and an assemblage of abnormal cells within the tissues.

The following diseases involving inflammation are mentioned because they are encountered rather frequently in medical practice. From the head downward they are:

Meningitis.—An inflammation of the membranes (*meninges*) covering the brain—usually a suppurative inflammatory process except in the less rapid tuberculous form.

Conjunctivitis.—Inflammation of the *conjunctiva,* the membrane which covers the white portion of the eyeball and lines

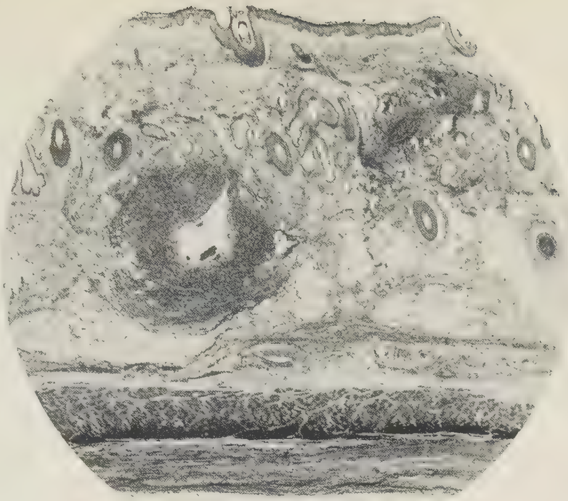

FIG. 23.—INFLAMMATION AS REPRESENTED BY AN ABSCESS IN THE SUBCUTANEOUS TISSUE

The dark area is formed of a collection of innumerable leukocytes.

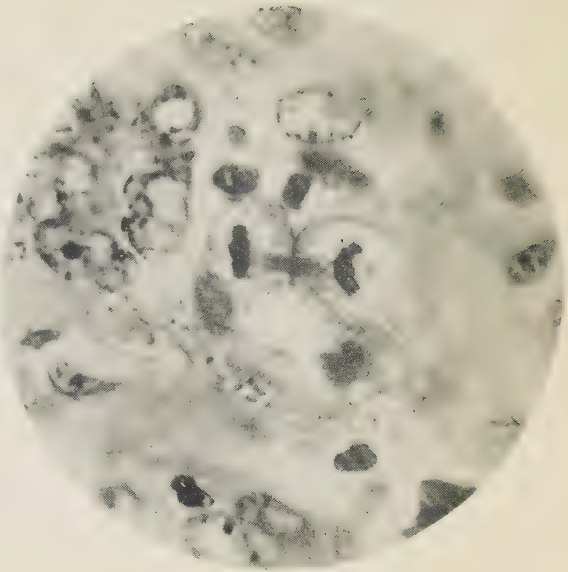

FIG. 24.—CANCER: A CELL UNDERGOING DIVISION INDICATING ACTIVE GROWTH

(Compare Figure 1, No. 2.)

the eyelids, which may be either simple, as in *pink-eye,* or pus-forming, as in *gonorrheal infection.*

Rhinitis, Coryza, or Cold in the Head.—A catarrhal[1] inflammation of the lining membrane of the nasal cavities.

Sinusitis.—This is an inflammation within one of the air chambers that connect with the nasal cavities. It may be either catarrhal or suppurative.

Tonsillitis.—Inflammation of one or both tonsils. In *peritonsillar abscess* or *quinsy,* pus forms in the tissues about the tonsil.

Diphtheria.—Another form of inflammation of the throat.

Otitis Media and Mastoiditis.—Inflammation of the middle ear, or of the mastoid cells which are backward extensions of the middle ear—catarrhal or suppurative. When fluid collects in the middle ear painful pressure is exerted on the drum (earache) which may burst, causing "running ear."

Carbuncle.—The back of the neck is a favorite site for an inflammation of the skin and cutaneous tissue known as carbuncle. It is similar to a large boil, save that it has a number of centers of pus formation and is prone to invade the subcutaneous tissue to a greater depth.

Laryngitis.—Inflammation of the lining of the larynx—usually catarrhal, but both tuberculosis and syphilis may cause chronic inflammation of the larynx.

Adenitis or Swollen Glands of the Neck.—Inflammation of one or more lymphatic glands of the neck, either simple or suppurative. This inflammatory process may be acute or chronic, the latter being commonly due to tuberculosis[2] of the gland.

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[1] Catarrhal inflammations are mild or non-suppurative inflammatory processes of mucous membranes. Normally, mucous membranes secrete a substance called mucus; in inflammation, this is formed in greatly increased quantities. Some quack advertisements state that "catarrh" is a serious malady; this is not true.

[2] While tuberculous glands are observed most frequently in the neck, any of the lymph glands of the body may become the seat of tuberculosis. Postmortems in unselected cases have shown that tuberculosis is present somewhere in the body in more than nine-tenths of all deaths.

Arthritis.—Inflammation of one or more joints, either simple or suppurative.

Septic hand or foot.—Suppurative inflammation of the hand or foot, usually secondary to a prick or an abrasion of the skin.

Mastitis.—Inflammation of the breast.

Bronchitis.—Inflammation of the air passages leading into the lungs, usually catarrhal.

Pneumonia.—A peculiar form of inflammation involving part of one or of both lungs. In addition to the changes of ordinary inflammation within the area of involvement, there is an outpouring of fluid and of cells which fills the air spaces. Moreover, the fluid becomes coagulated much as blood-clots do, so that the lung tissue becomes solidified like liver, instead of retaining its normal spongy consistency. Ordinarily, suppuration does not occur. With recovery, the clotted material in the air spaces resolves and is re-absorbed by the circulation.

Lung Abscess.—Rarely after pneumonia, but more frequently from other causes, a suppurative inflammation or abscess occurs in the lung.

Tuberculosis of the Lung.—This is a chronic inflammation, situated usually in the upper part of one or both lungs. In all tuberculosis, the first alteration is the development of minute areas of chronic inflammation not larger than a pinhead, known as *tubercles.* These tubercles grow larger and coalesce, with varying results. In some instances the inflammatory changes about them produce some consolidation, as in pneumonia; in others, fibrous scar tissue formation is most in evidence; sometimes lung tissue is destroyed, producing air-containing cavities connecting with the air passages. Blood-vessels may become eroded, causing expectoration of blood.

Pleurisy.—Inflammation of the pleura or surface membrane of the lung may be of two grades. Either there is only a roughening of the surface by the formation of a shaggy coating (*dry pleurisy*); or, in addition, there is an oozing of fluid

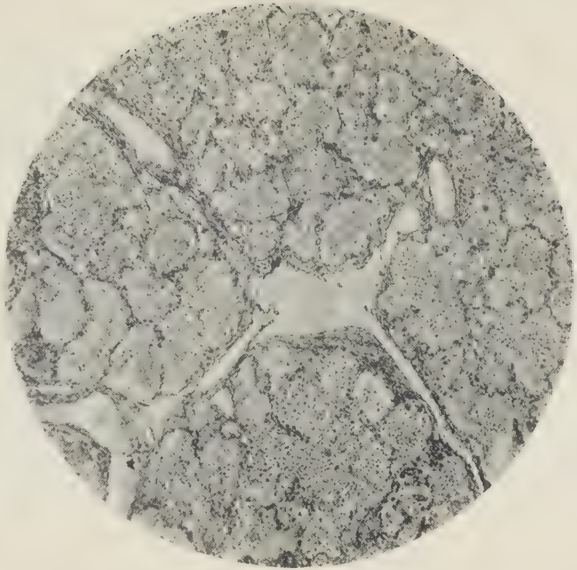

FIG. 25.—MICROSCOPIC SECTION OF THE LUNG IN PNEUMONIA (COMPARE FIGURE 14)

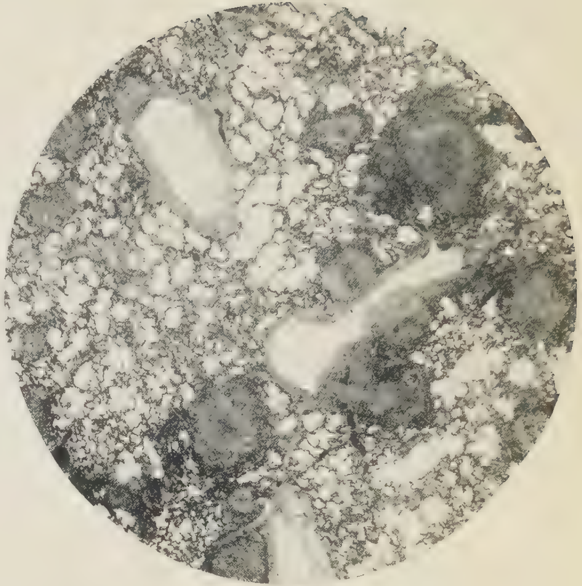

FIG. 26.—TUBERCLES IN THE LUNG (COMPARE FIGURE 14)

into the pleural cavity (*pleurisy with effusion*). In the latter variety, much fluid may collect and exert pressure upon the lung so that it cannot fill with air.

Empyema, Suppurative or Purulent Pleurisy.—A collection of pus in the pleural cavity, occurring most frequently as a complication or sequel of pneumonia.

Endocarditis.—Inflammation of the inner lining of the heart or of its valves.

Myocarditis.—Inflammation of the heart muscle. This term is somewhat elastic and may include changes which are more properly classified as degenerations than as true inflammations.

Pericarditis.—Inflammation of the outer surface membrane of the heart—dry or wet as in pleurisy, or purulent as in empyema. If there is much fluid in the pericardial cavity, it may interfere with the filling of the heart during diastole.

Gastritis.—This means inflammation of the stomach, but it is a term which is better avoided, since most of the ordinary irritated conditions of the stomach are not classified as true inflammations. The word is derived from the Greek *gastron,* meaning the stomach, and has no connection with the modern word *gas.*

Enteritis and Colitis.—Inflammations, usually catarrhal, of the small and large intestines respectively.

Typhoid Fever.—A disease in which the chief lesion or structural change is an inflammation of certain lymphatic structures in the walls of the lower part of the small intestine. The inflammation is not a true suppurative one, but it causes destruction and sloughing off of tissue and so results in *ulcers*[3] in the intestinal lining. These ulcers are sometimes deep enough to produce hemorrhage; they may also perforate the wall of the intestine, so that its contents escape and cause peritonitis.

Appendicitis.—Inflammation of the vermiform appendix, frequently suppurative. The gravity of appendicitis lies in the fact that inflammation may extend from it to the peritoneum.

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[3] An ulcer is loss of tissue from the surface of any part of the body.

Peritonitis.—Inflammation of the *peritoneum,* which is the membrane covering the stomach, the intestines, and other abdominal organs, and lining the abdominal cavity in which these organs lie.

It is so important to understand the abdominal or peritoneal cavity and so difficult to describe it clearly that a familiar comparison may be of value. In dressing a recently killed chicken, one finds that the knife has to pass through only a thin layer before reaching a cavity. This is the abdominal or peritoneal cavity of the chicken. If a finger is inserted, the cavity is found to have a smooth lining and to contain movable structures, all of which appear to have a smooth glistening surface. This surface is the peritoneal membrane. It can readily be understood that if the finger can be moved freely about in this cavity and among the intestines and other organs, any fluid which gains access to the cavity may easily spread throughout it in just the same way; and if this fluid contains bacteria, or any source of inflammation, the resulting inflammatory process naturally is not confined to one structure, but involves all of this inner cavity. This is what actually occurs in the condition known as general peritonitis. A little fluid containing bacteria which escapes from an inflamed appendix, or from a perforated ulcer of the stomach, or from an ulcer of the intestine in typhoid fever, or from an inflamed *gall bladder* (a sac which collects bile, situated below the anterior border of the liver), or from other inflammations in the abdomen, may induce an inflammatory process that eventually involves all of the extensive surface covered by peritoneal membrane. However, there is a natural defense mechanism which may limit the involvement. Directly after inflammation, the peritoneal membrane secretes a glue-like substance which gums surfaces together. If the leakage of the infectious material is slow and the intestine is not then functioning actively, this adhesive process may be sufficient to confine the peritoneal inflammation to a small area, so that only a local abscess results.

Peritonitis, therefore, is an inflammation of the peritoneal membrane, usually resulting in a collection of fluid in the abdominal cavity, although there is a dry form of minor importance which is very rare. Save for the tuberculous variety, to be described separately, peritonitis is practically always a suppurative inflammation, whether of the entire cavity (*general peritonitis*) or only of an enclosed pocket (*localized peritonitis* or *abdominal abscess*).

Gonorrheal Peritonitis.—This is a simple or suppurative inflammation of the pelvic cavity in women, secondary to gonorrhea. It differs from other forms of acute peritonitis in that it frequently recovers without surgical drainage.

Tuberculous Peritonitis.—This is a chronic inflammation of the peritoneum due to tuberculosis; ordinarily it does not become purulent, but it often causes an accumulation of clear fluid in the abdomen, and it always results in the development of fibrous scar tissue.

Cholecystitis.—This is an inflammation of the gall bladder, which is a blind sac connecting with the bile duct, lying against the under surface of the liver near its anterior edge. Most frequently it is chronic and connected with gallstones, but it may become suppurative. The inflammation may cause peritonitis.

Nephritis.—Inflammation of the kidneys. This term includes various alterations some of which may be more properly considered as degenerations. Most varieties are non-suppurative.

Pyelitis.—This is a suppurative or pus-producing inflammation of the cavity in which the kidney accumulates the urine before discharging it through the ureter to the bladder. Often there is some accompanying obstruction to the excretion of urine, as a predisposing factor in producing the inflammation.

Cystitis.—A catarrhal or suppurative inflammation of the lining of the urinary bladder.

Urethritis.—Inflammation of the urethra or outer urinary passage, the commonest form of which is a suppurative inflammation due to gonorrhea.

Epididymitis.—A simple or suppurative inflammation of the *epididymis,* a structure situated in the scrotum beside the testicle, which is usually due to gonorrhea.

Prostatitis.—Inflammation, simple or suppurative, of the prostate gland, which may occur independently or in gonorrhea.

Salpingitis.—Inflammation of the fallopian tubes, usually suppurative and sometimes referred to as *pus-tube.* It is usually secondary to gonorrhea or to infection in childbirth. Tuberculosis is an occasional cause.

Phlebitis.—Inflammation of a vein, associated with formation of blood-clot within the vein but not with formation of pus.

Osteomyelitis.—Suppurative inflammation of a bone, with a tendency to purulent invasion of the bone-marrow. Some of the bone is destroyed and such dead tissue must be removed surgically before healing can occur.

In the inflammations mentioned here only the visible local changes have been described, except that in some instances their mechanical, local effects have been mentioned. Their individual systemic effects, or the ways in which they affect the body in general and life as a whole, which play a greater part in producing the symptoms of many of them, will be discussed subsequently in the chapters on particular diseases.

DEGENERATIONS

Gangrene.—All parts of the body are subject to influences which may cause either destruction of tissue or its local deterioration, the rest of the body remaining unchanged. Aside from such obvious causes as burns and frostbite, the most frequent cause of such change is obstruction or diminution of the blood supply to such areas.

Gangrene is the term applied to death of local tissues. If the destruction is extensive, the dead tissue undergoes moist decomposition resulting in a general poisoning which usually proves fatal; but if only a small area is involved, the dead tissue separates and healing occurs as in wounds. If the external causes such as burning or freezing of tissues are disregarded, gangrene is due almost invariably to a local interference with the circulation. If an artery of the lower extremity is obstructed, as by a blood-clot carried in the circulation, or by a tourniquet kept on too long, gangrene of the leg and foot results. In elderly persons, if the natural narrowing of an artery incidental to arteriosclerosis [4] goes on to complete obstruction, gangrene of the foot develops. In diabetes, a similar gangrene of the foot occurs at earlier ages. Certain infections in war wounds may likewise produce gangrene by the obstruction of many small vessels instead of by closure of a single large artery.

When gangrene develops in any visible structure of the body it first becomes bluish or purplish in color and then brownish black. Unless the amount of dead tissue is so small that it can dry and fall off, its decay is attended by an extremely foul odor.

Arteriosclerosis and Arteriosclerotic Degenerations.—It is said that "a man is as old as his arteries," and this aphorism is true to a degree. All of the gradual changes incidental to old age are apparently not to be explained by changes in the arteries, but many of the maladies peculiar to old age are definitely due to such changes.

Anatomical examination of the linings of the arteries even in early middle age show beginning specks and patches not present in the arteries of youth. These are the indications of the degenerative process known as *arteriosclerosis,* which is not strictly a disease, but rather a normal accompaniment of advancing years. It is present in every one in or beyond middle life. Moreover, many persons live to old age and show a high degree of arteriosclerotic change, but in spite of this fact have no symptoms directly referable to such change. From its inappreciable beginning, the arteriosclerotic process advances gradually until there is a perceptible thickening of such arteries as are palpable through the skin. Anatomical examination shows the lining of the arteries to be roughened and the walls thicker than normal. Frequently there is also a lengthening, which causes it to lie in bends, like a winding river on a map, rather than in a straight course. This is often noticeable in the temporal artery, even when the general arteriosclerotic process is not abnormally advanced for the age; it is a peculiarity rather than a serious sign.

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[4] See following section on Arteriosclerosis and Arteriosclerotic Degenerations; also section on Arteriosclerosis in chapter entitled Diseases of the Heart and Circulation, p. 284.

In the later stages of arteriosclerosis, lime salts are deposited in the thickened arterial walls, and in pronounced instances the artery feels beaded and hard. It may become so rigid as to have no perceptible pulse. Less blood flows through such arteries, but only in rare, extreme instances does the flow stop entirely and gangrene result.

Individuals display great differences in regard to arteriosclerotic change, even though the process is common to all in some degree. The age of onset is extremely variable, as well as the degree of change at any given age. Some have thicker arteries at forty than others at sixty, and of two persons of seventy, one may show extreme thickening and the other only moderate. Moreover, the degeneration is not uniformly distributed throughout the body, being frequently more pronounced in certain arteries than in others. One person may have "pipestem" arteries at the wrists, or sclerosis of arteries of the leg which has caused gangrene of a foot, with relatively little arteriosclerosis of internal arteries; conversely, there may be sclerosis of internal arteries which has produced injury to internal organs, such as the kidneys or the heart, when relatively little thickening of the external arteries can be felt.

The actual cause of arteriosclerosis is unknown, but the process is considered as one of deterioration from long or overactive service. It develops earlier in some families than in others. An overactive life, either physical or mental, and also overeating, seem to accelerate it.[5] A calm and moderate mode of life seems to delay it.

Arteriosclerosis produces symptoms of disease only in its advanced stages, when the function of the arteries becomes so seriously affected that they fail to maintain the circulation. The process is somewhat similar to the rusting of iron pipes. For a long time there is no difficulty, but the flow through them gradually becomes less free and ultimate obstruction, or even a break with resulting leakage, may occur.

Complete obstruction has already been mentioned as a cause of gangrene of the foot in old people.

Incomplete obstruction, in which the flow of blood continues but at a rate insufficient to supply the needs of the tissues, results in their degeneration, with gradual disappearance of their special cells and an increase of fibrous or scar tissue in their place. The function of an organ becomes impaired in proportion to its loss of cells.

As mentioned, individuals differ in the structures most affected by the arteriosclerotic process. Thus, when arteriosclerosis develops to a harmful stage, one organ usually becomes unable to function before the others fail. The kidneys, the heart, and the brain are the organs most subject to degeneration in consequence of sclerosis of their arteries with resultant insufficient circulation.

As a result of sclerosis of their arteries, the kidneys become smaller and harder. Microscopic examination shows that a proportion of their functional cells have been lost and are replaced by scar tissue; and, since failing kidneys demand higher blood-pressure to enable their remaining parts to work harder, the heart becomes enlarged from overwork, just as any other muscle becomes larger by constant heavy duty.

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[5] Syphilis causes somewhat similar changes in arteries, but is not related to true arteriosclerosis.

When the coronary arteries are partially clogged, the heart becomes more fibrous and less muscular, and consequently less efficient.

In arteriosclerosis of its vessels the brain may show only general cellular degeneration, or it may reveal local areas of softening and fibrous changes. The mental deterioration of old age is attributed to such degenerations. In old people the arteries of the brain are also apt to burst, causing bleeding into the brain substance. This is what occurs in the "shock" or "stroke" of *apoplexy.*

Aneurysm is a relatively rare but serious result of arteriosclerosis or, more frequently, of syphilis of an artery. It is a bulging of an artery which results from a weakening of its wall at some point, much as an automobile tire may bulge before it actually bursts. Aneurysms, either small or large, may occur in any artery, but the most serious are those of the aorta.

Arteriosclerotic degenerations and hemorrhages may occur in the retina where they may be seen by means of the ophthalmoscope.

In organs and tissues of the body other than those already mentioned, arteriosclerotic changes do not often occur to the extent of causing symptoms of disease.

Other Degenerative Changes of Body Cells.—Apart from the gradual degenerations which are due to diminished blood supply in consequence of arteriosclerosis, the cells of the various tissues and organs of the body may undergo other abnormal microscopic changes. In prolonged fevers, and in certain other conditions of disease, the body cells may be visibly enlarged and may show some obscuring of their markings—an alteration known as *cloudy swelling*. The more striking abnormal cellular condition known as *fatty degeneration* may be considered as a more advanced stage of the same change. Fatty degeneration of a cell is marked by the appearance of minute droplets of fat within it, the fat presumably being formed by degenerative change of the normal protoplasm. This has no relationship to the deposit of fat in obesity. Such fatty degeneration is best illustrated in certain varieties of nephritis [6] in which it is conspicuously present, and seems also to involve imperfect functioning of the cells involved. It is seen also in the heart, the liver, and other cellular structures.

Other forms of degeneration of body cells may be differentiated in microscopic pathology, but as they are of comparatively rare occurrence discussion of them may be omitted.

EDEMA OR DROPSY

One variety of painless swelling of the tissues occurring independently of inflammations or injuries is that known as edema or dropsy; it is caused by the accumulation of watery fluid in abnormal amounts in the connective tissues and cavities of the body. This condition is usually the result of some abnormal resistance to the circulation of blood in the veins toward the heart, so that the veins and capillaries are engorged and seem to permit water to ooze from their walls. Thus, edema frequently occurs in heart disease, in which the blood stagnates in the veins because the heart cannot pump it onward fast enough. This usually manifests itself as a painless swelling of the lower extremities, but it may also involve the abdomen or the chest.

Edema may likewise occur without circulatory disturbance, particularly in kidney disease. Just why it does so is not known. In this variety of edema, swelling of the face and of the eyelids may be conspicuous.

[6] See chapter entitled Diseases of the Kidneys and Urinary System, p. 339.

CALCULUS OR STONE FORMATION

Collections of hard, pebble-like material sometimes develop in the gall bladder and bile ducts, in the pelvis of the kidney, in the ureters or in the bladder, and occasionally in other discharging ducts of the body. These vary in size from fine gravel to pigeons' eggs. They may produce no symptoms, but they often tend to induce inflammation and frequently cause obstruction of the passage in which they occur.

TUMORS OR NEW GROWTHS

The word *tumor* is derived from the Latin *tumere* meaning to swell, but medically it has a restricted meaning denoting only those circumscribed swellings that are produced by an abnormal new growth of tissue, and is not used to include the generalized swellings due to inflammation or to edema of normal tissues.

Tumors are of many varieties and may occur in almost any part of the body. On anatomical examination, they are found to be abnormal additional masses of tissue, differing either in form or in structure from the normal tissues of the organ in which they occur. On microscopic examination, some are found to be composed only of normal body tissues abnormally arranged, such as fibrous tissue or fat tissue. In one curious form of tumor (*dermoid*), hair, teeth, and bits of bone may be found within the growth. Other tumors are composed of tissue unlike any of the normal tissues of the adult body, having characteristics resembling those of the undeveloped tissues of the embryo.

The cause or causes of tumor formation are disputed and obscure. The best supported theory is that tumors originate in cells which, in the embryo, have failed for some unknown reason to develop normally, and which in later life have undergone a delayed and abnormal development.

From the point of view of their effects upon the life and health of the individual, tumors may be divided into two groups, *benign* and *malignant*.

The first class is composed of those tumors which are relatively harmless save that they may exert mechanical pressure upon their surroundings. Thus, a large fatty or fibrous tumor of the surface of a part of the body, as of the scalp, may be only an inconvenience or blemish. On the other hand, a benign tumor may occur in the brain or within the chest and cause serious symptoms by pressure upon the surrounding structures.

Malignant tumors, however, do not merely grow at the site where they originate, but reproduce themselves in other parts of the body. They tend to form fingerlike extensions into the surrounding normal tissues,[7] and to transmit themselves along the lymphatic channels, inducing a growth of secondary tumors in lymph glands. The elements of such tumors may also be carried by the blood-stream to distant parts, particularly to the bones and to the lungs. Malignant tumors as a rule grow faster than benign tumors, and their ill effects are not confined to pressure. In their advanced stages, they produce a fatal emaciation and weakness not attributable to pressure.

Carcinoma or *cancer* is the most frequent form of malignant tumor. It originates in the skin or in the surface membranes of the internal organs or ducts and extends particularly by the lymphatics. *Sarcoma,* another class of malignant tumor, does not originate on surfaces or mucous membranes; it has a greater tendency to disseminate by the blood current.

The important practical difference between benign and malignant tumors is that if benign growths are accessible by surgery, they are thoroughly removable and do not recur. On the other hand, it is difficult or impossible to remove malignant tumors thoroughly, except in the earliest stages of their growth;

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[7] Cancer, derived from the Latin word meaning a crab, is so named because of these extensions.

and if complete removal is not effected they advance to a fatal termination.

Special Benign Tumors.—The most important tumors of the benign group are the so-called *fibroids of the uterus.* These are new growths which develop in the uterine walls, and may protrude either into its central canal or upward into the abdominal cavity. The former are likely to produce bleeding, and all of them are unfavorable to the normal course of pregnancy. Large fibroids cause enlargement of the abdomen and pressure symptoms, but after the menopause they tend to decrease in size and to disappear. Sometimes they undergo necrosis or gangrene. Occasionally a malignant tumor (carcinoma or sarcoma) develops at the site of a fibroid.

The breasts and ovaries are frequently the site of other significant benign tumors. These are usually cystic in character, that is, the tumorous growth is composed of numerous cysts, which are tumors containing enclosed sacs of clear, watery fluid.

Small fatty or fibrous tumors of the skin are common but of little consequence.

Special Malignant Tumors.—In most instances, *cancer* is a disease of people beyond forty years of age.

The variety of cancer known as *epithelioma* may occur anywhere upon the skin but appears most frequently on the face. It is a slowly extending painless ulcer or "sore," with a margin which whitens when the skin is stretched. Epithelioma is the least serious type of cancer, as it is usually curable if treated early in the course of the disease.

Cancer of the lip has a similar appearance, but it is usually more indurated and grows more rapidly. It requires a more extensive operation for its removal than does epithelioma, but of the earlier cases a large proportion are curable.

Cancer of the tongue, gums, or cheek is of particularly rapid growth. A small painless swelling or prominence may be the first thing noticed; more frequently, however, there is an open, easily bleeding, comparatively painless ulcer with a little induration or thickening of its base and margin. Extension of the disease through the lymphatics produces subsequent enlargement of the lymph glands of the neck.

Cancer of the larynx is a cause of gradually developing hoarseness in older men. If diagnosed early, it is frequently operable.

Cancer of the esophagus or gullet is a somewhat rare condition. It causes increasing interference with the passage of food.

Cancer of the stomach usually begins at or near the pylorus or outlet, frequently producing symptoms of partial obstruction. Digestive disturbances invariably develop, and in the later stages a mass is palpable in the upper part of the abdomen.

Cancer of the large intestine, or of its lower end, the *rectum,* causes obstructive symptoms, and usually bloody stools. The tumor may or may not be palpable. Rectal cancer is frequently removable.

Cancer of the cervix or outlet of the uterus is most frequent in women who have borne children. In childless women, cancer of the body of the womb may occur. In both conditions bleeding independent of menstruation is likely to be a symptom. This variety of cancer is frequently removable by a radical operation involving removal of the uterus.

Cancer of the breast is one of the causes of a hard mass in the breast. Any mass in the breast demands prompt medical examination.

These are the structures of the body in which cancer usually originates, but other sites are attacked less frequently.

Theoretically, if cancer could be removed surgically in its early stages it would be curable. Practically, however, its onset is so insidious that early diagnosis and prompt operation is not possible in all cases. At present, the percentage of cures is highest in those instances in which the disease has a natural tendency to progress less rapidly, and in which its site is visible. Cancer of the stomach and esophagus, and of the prostate gland, are very rarely permanently curable. In other locations, cancer is less hopeless; the percentage of cures for each region may be estimated from surgical statistics, but the prognosis in any individual case is also governed by its particular circumstances. However, there are selected cases of incurable cancer in which surgery may prolong life and diminish suffering even though the tumor may be irremovable.

Radium and X-ray have a place in the treatment of malignant growths. As curative agents, however, they are indicated only in the least threatening varieties such as epithelioma; in more serious tumors such treatment is seldom curative and is invariably more painful than surgery. In inoperable cases they have some value in retarding the progress of the growth, but they are not curative. Other methods of treatment are under investigation, but surgery is still the chief reliance.

Cancer which is surgically irremovable in its early stages extends to lymph glands, bones and other structures and becomes more or less widely disseminated. The presence of pain in the early stages of the disease depends chiefly upon the site of the growth; in tissues which resist expansion, such as bones, the pain is usually more severe. Pain is also present if a nerve is involved, or if there is ulceration either on the body surface or in the alimentary canal. The later stages of the disease, particularly of the primary growth, may be associated with pain of all degrees of intensity; secondary (*metastatic*) tumors, however, may cause no pain and but little discomfort. There is always progressive emaciation, the disease proving fatal usually within two years of its onset, and frequently sooner.

The incidence of sarcoma is less than that of carcinoma. Perhaps the most frequent variety is that known as *hypernephroma* which develops in or near a kidney. Another significant variety develops in long bones, usually near a joint.

In sarcoma, a secondary metastatic tumor may be larger and may cause more symptoms than the primary growth. Thus, large tumors of the liver or of the lung may be secondary to small growths within the eyeball or to simple blue-black moles.

MALFORMATIONS AND DISEASES OF DEVELOPMENT

Congenital abnormalities are comparatively rare. Perhaps the most frequent is that known as *harelip,* an open division of the upper lip into two parts. The roof of the mouth may be similarly divided, a condition called *cleft-palate.* Webbed fingers and extra digits occur. More remarkable abnormalities, such as so-called Siamese twins, occur and may be seen in circus side shows. Many of these conditions can be improved by surgery. The cause or causes are unknown; occasionally the same deformity may have a familial tendency.

Certain other abnormalities may be present in latent or inconspicuous form at birth, but may develop into marked deformities as the body grows. The most significant of these are *congenital dislocation* of one or both *hips, club-foot* and *wry-neck.* Early recognition and prompt treatment do much to correct them.

If the process of birth is unusually difficult the child may sustain injuries. The most serious of these is rupture of blood-vessels within the skull, resulting in paralysis or mental impairment. Less grave is paralysis of one arm caused by injury to nerves in the neck above the shoulder. Such injuries, however, are comparatively rare.

Rickets [8] is the chief cause of deformities developing in early childhood. One of the results of rickets is that the bones do not harden because they fail to become impregnated with lime salts. Thus, with the increase of body weight incidental to growth, the bones become bent or distorted, as in bowlegs, knock-knees, curvatures of the spine, and malformations of the chest.

Humpback and permanent stiffness of the hip or of the knee are results of *tuberculosis of the bones* in childhood. In such cases the age-old suspicion that "the nurse must have dropped the baby" is unfounded. Particularly in the vertebræ, tuberculosis causes extensive softening and destruction of bone which may lead to great deformity if early treatment is not instituted.

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[8] See section on Rickets in chapter entitled Infancy and Its Disorders, p. 428.

Infantile paralysis is primarily an inflammation which causes degeneration of certain nerve cells in the spinal cord or brain, with resultant loss of function of the nerves that emanate from those cells, producing paralysis of the muscles supplied by these nerves. In a few instances the muscles of respiration are paralyzed, causing death. More frequently, however, only certain less vital muscles are affected. The unopposed activity of the muscles that remain unaffected tends to produce deformity in addition to paralysis.

CHAPTER XVI

PATHOLOGICAL PHYSIOLOGY, OR GENERAL REACTIONS TO DISEASE

FEVER

In many inflammations of more than slight extent, and also in many diseases without local inflammation, the body temperature rises above normal and certain disturbances occur, such as headache, flushing and sensation of heat, backache, and general discomfort and weakness. This condition is called *fever*, its essential factor being the elevation of body temperature above its normal level of 98.6° F. The accompanying sensations are incidental and variable.

The mechanism of its production, however, is not conclusively known, and its significance is still in the realm of surmise. The degree of temperature is determined by the thermometer. An increase in body temperature might be caused, theoretically, either by increased heat production, or by decreased radiation of heat from the body surface, or by a combination of these factors. The last named is probably the true explanation. In fever there is increased oxygen consumption, which suggests increased heat production. But in addition to this, while the temperature remains high, sweating is not active, suggesting a failure of the process of heat dissipation. Thus, there is reason to believe that fever is due to increased heat production combined with insufficient heat elimination.

The cause of this reaction is unknown; it is a fact, however, that foreign proteins, such as milk, when injected into the tissues through the skin will cause fever. This is suggestive that in inflammations and infections there may be a development of abnormal protein substances within the body which act similarly. Such substances may be products either of bacterial growth or of alterations in body tissues, the formation of such products being the results of disease.

There are likewise grounds for surmising that fever may be a protective reaction, but this fact is not definitely established. Extremely high body temperature, such as 108° F., if of more than very brief duration, is usually fatal. On the other hand, it may be that the more moderate febrile temperatures are better left to nature than to drugs.

With fever of long duration there is wasting of body tissues, especially of the subcutaneous fat. Chills with shivering, or chilly sensations with less violent shaking, are frequent accompaniments of sudden rises of temperature. They are probably the sensory result of the condition of the skin which is balking against increased elimination of heat, together with reflex impulses transmitted to the muscles. Sweats, meaning unnaturally profuse perspiration, often occur as elevated temperature falls, although they are not always to be explained in this way.

In children, high temperatures may result from relatively slight causes. Conversely, feeble old persons are not prone to high temperatures, even in serious illnesses.

Temperatures below normal, particularly in the morning, are of frequent occurrence and seem to accompany debility or inactive states of the general body processes. Save when there is suspicion that the debility may be due to early tuberculosis, and in connection with deficient function of the thyroid gland, subnormal temperatures are of no consequence.

There are individuals who say that they "never have a temperature," and when such persons are indisposed and have slight elevations of temperature, they believe their condition to be as serious as those disorders of others in which high fever is present. This is an error. Definite febrile diseases manifest more or less characteristic temperatures in all people. The disagreeable sensations of illness, it is true, are not always proportionate to the degree of fever; but any significant disorder which should cause fever invariably elevates the temperature, save occasionally in old age.

POISONINGS

Aside from those which act on the skin, like poison ivy, poisons are generally substances which cause harmful effects when taken internally. Some strong acids and alkalies cause chemical burns of the mouth, of the esophagus, and of the stomach. Pain, vomiting, and perhaps diarrhea result, and there may be subsequent symptoms from contracting scars. Other ingested substances may cause less severe irritations of the stomach and bowels, but nevertheless result in diarrhea and perhaps vomiting. Arsenic and the poisons of decomposed foods are examples. Many drugs, having still milder actions of this type, are used as cathartics or as emetics.

Some poisons produce their chief effects only after absorption from the alimentary tract; for instance, corrosive sublimate (mercuric chloride) taken by mouth causes injury to the kidneys. Degenerations of the liver result from other poisons, such as phosphorus. If taken in concentrated form for long periods, alcohol may cause a fibrous degeneration of the liver called *cirrhosis*.

Still other poisons attack the red corpuscles of the blood in various ways; acetanilide, the commonest ingredient of headache preparations, does this when taken in large doses. Carbon monoxide, as in illuminating gas, and in the exhaust gases of motors, destroys the oxygen-carrying power of the red corpuscles. Rattlesnake venom destroys red corpuscles. Probably some of the symptoms produced by severe burns, malaria, and certain bacterial infections, which cause the red corpuscles to break up and perhaps form poisonous substances, may be explained on this basis.

Poisons may also attack the nervous system, either the brain or the peripheral nerves, and cause permanent changes in nerve structures. Alcohol, lead, and arsenic do this. Many drugs, as well as the spontaneously formed poisons incidental to processes of disease, exert deleterious effects upon the nervous system, for the most part, however, transitory. In contrast with rattlesnake venom, cobra venom acts chiefly upon the nervous system.

Many substances produce effects upon the body which do not result in any demonstrable structural changes, but which may, nevertheless, prove serious or even fatal. Death may be caused by minute amounts of a considerable number of poisons derived from plants,[1] as well as from chemical compounds. The action of each of these varies but is characteristic. In cases in which they are indicated, pharmacology utilizes the minutest doses (one one-hundredth of a grain or less) of such highly potent substances in medicines, eliminating by means of exact dosage the danger of their more serious effects while their desirable, specific action is secured. Morphine, atropine, strychnine, quinine, digitalis, and arsenic are examples of poisons, small doses of which are useful as drugs. While most of them act upon the nervous system, the effects of others are directly upon organs, as on the heart or the kidneys, or upon the blood and tissues.

SHOCK FROM INJURIES

In all severe injuries, whether from blows, wounds, burns, or other causes, there are general symptoms of the condition known as *surgical shock,* in addition to local damage in the part of the body involved. This seems to be the effect of violent sensory impulses upon the nervous system, and is manifested most significantly by disturbance of the general circulation, with more or less serious results. In the most severe injuries there may be instantaneous death, which is probably the result of extreme shock. But typical surgical shock is usually an accompaniment of less severe injuries which are not fatal, or at least not immediately so. A person in this condition is pale and feels weak and faint; the hands and feet and the general body surface may be cold to the touch; the pulse is rapid and weak, and the blood-pressure is low. All of these effects are apparently due to a relaxed state of the arteries and capillaries, which in turn is the result of loss of that control of the arteries normally exercised by the central nervous system.

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[1] The extensive advertising of certain patent medicines as "vegetable" compounds, with the implication that they are harmless, will scarcely inspire confidence among those who are familiar with the tremendous potency of

In the more serious instances, surgical shock may prove fatal in the course of the hours following the injury; in the less serious cases, its effects pass, either slowly or quite rapidly. In some instances, the degree of shock is not at all proportionate to the injuries sustained or to the pain which has been caused. Thus some quite serious injuries may produce few general symptoms, while some trivial accidents like the sprain of a finger may be attended by well-defined evidences of shock. The mechanism of its production and its significance are still subject to conflicting theories.[2]

HEMORRHAGE OR BLEEDING

In the majority of instances, loss of blood is more terrifying than dangerous. The small amounts of blood lost from ordinary cuts or nosebleeds are of no consequence. A hemorrhage is not considered serious unless a pint of blood is lost, and even then there is no cause for alarm if the wound is closed so that it cannot bleed again. It is only when a large artery or vein is wounded that nature does not succeed in stopping the bleeding before the danger point is reached. In bleeding from a wounded artery, blood flows in spurts synchronous with the heartbeat. Bleeding from veins and from capillaries is continuous, less forceful, and non-pulsating.

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[2] For the principles of treatment, see section on Treatment of Shock from Injuries in chapter entitled Surgery, p. 388.

Wounds of the body surface and blows upon the nose are not the only causes of hemorrhage. The tissue changes of certain diseases may erode the walls of blood-vessels and cause escape of blood. Bleeding from the lungs may occur, particularly in tuberculosis. Vomiting of blood and the passage of bloody stools may occur in diseases which produce ulcers of the digestive tract. Uterine bleeding may occur in childbirth and in various diseases. Bleeding into the body cavities may likewise occur, so that much blood is lost from the circulation although none escapes from the body. Even in such instances it is only exceptionally that the bleeding does not cease spontaneously. From these internal sources, however, there is more danger of recurrent hemorrhage than there is from external wounds.

Slight bleeding is sometimes followed by fainting, which is probably due to fright and to the sight of blood rather than to its loss. This symptom is likely to occur not only in the wounded, but in those who see the wound, as there seems to exist in many individuals a profound psychic reaction when blood or wounded flesh is seen. Such faintness, however, soon passes.

Severe hemorrhages are serious, and in proportion to their amount are symptomatic of danger. When the loss of blood is sufficiently gradual for the effects to be observed, a rising pulse rate is noticeable. There is complaint of thirst, with a desire for fresh air, and there is apt to be an increase in the rate of respiration. When the loss of blood has been marked, there is loss of consciousness, extreme pallor, very rapid, weak pulse, and sighing respiration. These symptoms seem to be due to failure of the blood-vessels to fill adequately owing to insufficient blood in the circulation. The weakness of the pulse may be attributed to this. Loss of consciousness is due to insufficient blood supply to the brain. Apparently, the loss of blood volume rather than its oxygen-carrying power is chiefly responsible for this phenomenon.[3]

Cerebral hemorrhage or apoplexy[4] has its effects from the pressure caused by the escaped blood, and not from its loss.

Bruises, whether "black and blue spots" or the deeper swellings without discoloration of the body surface, are hemorrhages into the structural tissues.

FUNCTIONAL ABNORMALITIES OF SPECIAL ORGANS

While detailed discussions of impaired functions of the body must be deferred until individual diseases are discussed, certain fundamental types of improper function deserve preliminary mention. Just as we have studied the normal physiological processes of the various systems of the body, so their principal departures from normal in disease may be considered according to the same systems.

Heart and Circulation.—When the heart fails to do its work properly the most frequent symptom is breathlessness on exertion. This is because the function of the left ventricle is usually first impaired. As a result the veins and capillaries of the lungs become engorged, and in consequence their blood cannot be so thoroughly exposed to the air. Cough may likewise be present, due to edema[5] of the lungs. Thus, many patients with disease of the heart suppose that their lungs are responsible.

Palpitation or consciousness of the heartbeat may be present in heart disease, but of all patients who complain of this symptom only a small percentage have organic disease of the heart, and in many cases of heart disease there is no palpitation.

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[3] For the treatment of serious hemorrhage, see section on Wounds in chapter entitled Surgery, p. 383; for nosebleed, see chapter entitled Diseases of the Nose and Throat, p. 443.

[4] See section on Diseases of the Brain in chapter entitled Diseases of the Nervous System, p. 354.

[5] See section on Edema in chapter entitled Pathology, or Tissue Changes in Injury or Disease, p. 143.

A painless generalized swelling under the skin of the lower extremities, called edema, is due to heart weakness, but it may also result from other causes which produce retarded venous circulation. In the advanced stages of heart disease, there may be swelling of the abdomen, due to edema or to the accumulation of watery fluid in the peritoneal cavity.

Lungs and Organs of Respiration.—Breathlessness is a pronounced symptom when there is serious impairment of the lungs. This is manifest in pleurisy with effusion, in advanced tuberculosis, and in a chronic condition known as *emphysema* in which there is a thinning or wasting of lung tissue.[6] However, the lung apparently has a certain margin of reserve, so that less extensive disease does not cause breathlessness.

Coughing is a nerve reflex, controllable to some extent, by which tickling sensations in the windpipe or larynx produce forcible muscular contractions to expel air from the lungs. Obviously, the purpose is to raise sputum. There is, however, another less known mechanism which furthers the same object. The cells forming the lining of the windpipe have little, microscopic, fingerlike processes that constantly propel the secretion upward toward the larynx, from which it may be raised by clearing the throat.[7] Many people cough unnecessarily. If the impulse to cough would be restrained this other mechanism would ultimately function, and the irritation producing the cough would more readily subside.

Digestive System.—Perfectly normal digestion involves a complicated coördination or coöperation between the secretion of the digestive juices and the movements of the involuntary muscles of the stomach and intestine. Furthermore, these two processes are involuntarily governed in a complex and unconscious manner by the nervous system. There is reason to believe that certain sensory impulses exist which never manifest any conscious pain or discomfort but which are nevertheless sufficient to modify the motor and secretory functions. It is likewise true that emotional states have a pronounced effect upon digestive processes.

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[6] The shortness of breath in penumonia is apparently not due to the same cause.

[7] In whooping cough, the peculiar symptoms result from clogging of these microscopic fingers, which prevents their function.

Disturbances of digestion not indicative of actual disease are extremely common, and are frequently due to hurried eating with imperfect mastication, to overeating, to imprudent selection in eating and drinking, and also to emotional or other general influences. In a general way, such disturbances may be divided into two groups: (1) overactivity of the stomach with lack of coördination, causing complaints of acidity and of digestive distress; (2) underactivity or repression of gastric functions, with complaint of poor appetite and nausea rather than local distress.

The stomach may also behave abnormally when other abdominal organs are disordered, in fever, and in other conditions which are not primarily diseases of the stomach.

The significant diseases of the stomach involving structural alterations will be discussed separately.

Like the stomach, the intestine is susceptible to disturbance which may be regarded rather as its misbehavior than as a disease. Overactivity is expressed as diarrhea and "cramps"; sluggish, repressed, or incoördinated action results in constipation. The frequency of the latter, with its resultant annoying and occasionally serious effects, is partially due to habits of delicacy among civilized peoples of retaining waste material and gases when an animal or a savage would discharge them. This, as well as the more important intestinal diseases, will be discussed subsequently.

The Urinary System.—Sudden injury to the kidneys causes a cessation or a great diminution in the formation of urine; the presence of blood in such urine as is voided; and *albumin,* a soluble protein substance not usual in normal urine, may be found on chemical examination.

When the kidneys fail to excrete water, it accumulates in the tissues of the body, and usually manifests itself as edematous swelling of the face and about the eyes. Continued retention of waste products by the urine, a condition known as *uremia,* may result in convulsions, unconsciousness, and death. Inability of the kidneys to excrete urea and other waste substances may be gradually revealed by a tendency to pass larger quantities of urine, particularly during the night; but such urine is more dilute than normally having less solid material dissolved in it, and it may contain albumin. As function of the kidneys becomes impaired, chemical tests of the blood reveal increased retention of urea and other substances.

Subnormal function of the kidneys is accompanied by increase of the blood-pressure in all the arteries of the aortic circulation. This increase is probably provided to aid the incompetent kidneys to increase the excretion. Often the heart is unequal to this demand for additional work, so that symptoms similar to those of heart disease occur in patients with kidney diseases.

Obstruction to the passage of urine from a kidney, whether by a stone or any other cause, results in pain, called *renal colic.* Partial obstruction, if long continued, results in a stretching and thinning of the kidney known as *hydronephrosis.*

Obstruction to complete emptying of the bladder, which usually occurs in elderly men with enlargement of the prostate gland, causes stretching of the bladder and desire to void urine at frequent intervals. In other cases this symptom is caused by inflammations of the bladder, and in some women it may result from pressure upon the bladder by the womb.

Reproductive System, Male.—Partial or complete impotence occurs in old age, and may result prematurely from overindulgence. It may also be a symptom of various diseases, and of states of nervous debility. While quack advertisements find it a profitable subject for distortion and extortion, it figures little in medical practice. Most instances of alarm in this direction are due to temporary nervousness.

Sterility in marriages may be due to the male as well as to the female. Examination of the seminal fluid may show it to contain no spermatozoa, and hence incapable of fertilizing the ovum. This may be due to various causes of which previous gonorrheal infection is probably the most frequent.

Reproductive System, Female.—Painful menstruation is a common occurrence and its particular cause may be discoverable. Early medical advice is advantageous in such cases; if treatment is too long deferred in the hope that the difficulty will be outgrown, it may become more firmly fixed.

Sterility in the female may be due to imperfect development of the genital organs, or, more frequently, to less definite abnormalities that interfere with admission of spermatozoa to the uterus. Gonorrheal infection of the fallopian tubes is one cause of sterility. Failure on the part of the female to experience active reactions in the sexual union does not prevent conception.

Various unfavorable conditions may cause expulsion of the fetus from the uterus at any time between conception and the end of the normal period of gestation. The earlier expulsions are called *abortion* and *miscarriage.* Labor in the eighth or ninth month is called *premature labor,* and with careful management the child may live.

Toxemia of pregnancy and *eclampsia* are terms applied to an abnormal condition which may develop during pregnancy. Its symptoms simulate acute failure of the kidneys.

Difficult labor may be due to several causes, notably to deformity of the bones of the pelvis, to abnormal development of the child, or to abnormal positions of the child in the uterus. These may be detected or predicted with considerable accuracy by examination before labor.

The Nervous System.—As already indicated, injury or disease of the peripheral nerves causes either loss of sensation, or loss of motor control. Paralysis of a muscle by injury to or destruction of a peripheral nerve is always a flabby or *flaccid* paralysis; in contrast with this, paralysis due to a lesion within the brain leaves the muscle in a state of partial contraction, so that the parts affected become somewhat rigid.

Many diseases of the nervous system exist, some of which will be described later. Some depend upon known structural alterations such as hemorrhages, abscesses, degenerations, or tumors, while others seem to exist independently of such changes.

There is sound reason to believe that the conditions grouped under the vague, general classification of "nervousness" are either conscious or unconscious misinterpretations, or manifestations of disorder of some other system of the body. Thus nervousness, as the term is generally understood, may scarcely be considered a disease of the nervous system. At least those stringlike structures called the nerves are only passively and secondarily concerned in "attacks of nerves" or "nervousness."[8]

DEATH

Death may be considered as the simultaneous cessation of all the physiological and chemical processes of the body which together constitute life. Recovery from transitory lapses in the functions of various organs may sometimes occur, but any more than a brief cessation of the activities of any vital system of the body, particularly of the circulatory or respiratory functions, is quickly followed by a cessation of all others. This causes death. Sensational rumors of persons mistakenly pronounced dead while still alive have no foundation in fact.

After death, there is a brief period in which the individual cells of the body may still retain the reactions of cell life. Soon, however, the body cools to the temperature of the air surrounding it. Rigidity of all muscles of the body likewise occurs, causing the limbs to remain in whatever position they may be as this change develops. Just as this represents death of the muscle cells, so do all other cells of the body cease to show evidence of life and begin to undergo the process of decomposition.

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[8] See section on Neurasthenia in chapter entitled Diseases of the Nervous System, p. 376.

But of greater interest and importance are the processes which precede death and occur immediately before it. These are not entirely known, and seem to be various.

In instantaneous death from extremely violent injury, the result probably represents shock to the central nervous system with complete paralysis of its action. In fatal electric shock, which may be similar, there is immediate loss of consciousness with paralysis of respiration, the heartbeat ceasing only after a certain interval. However, such cases form but a small proportion of the great total of deaths, and are in a group by themselves.

Fatal hemorrhage is also comparatively rare, and its effect is apparently produced differently from that of most other causes of death. Here, the direct cause of death is probably the mere loss of blood, and the consequent insufficient blood supply in the circulation, although the arteries and the body as a whole may be otherwise normal. This insufficient filling of normal arteries results in a lowering of the blood-pressure. When the blood-pressure in the aorta falls below a certain point, consciousness is lost and the heart will not continue to beat.

In certain diseases of the heart this organ comes to a final standstill by relaxing or failing to contract, apparently because of its own diseased state. Certain poisons also paralyze the heart in relaxation; others stop the heart in permanent contraction; while still others paralyze the brain, or cause cessation of breathing. But all of these likewise represent unusual manners of death.

In most instances, the primary factor of death in consequence of disease does not seem to be a direct paralysis, either of the heart or of the breathing. The sequence of events most consistent with what is observed is more complex. First, the disease produces abnormal effects known as its symptoms. Whether these consist of pain, fever, breathlessness, sleeplessness, or malnutrition, they produce an increasing state of exhaustion. At first there are no threatenings of immediate death; later, however, as one watches the patient's course through hours and days, his endurance becomes more and more questionable. For hours or even for days, life hangs in the balance. If the cause of the condition can be eliminated recovery may occur; supportive treatment will do something to promote longer survival; but if the disease continues to attack he must in the end succumb.

In unfavorable cases, there is finally a sudden and rapid change for the worse. This change is marked by a weakening of the pulse, but is accompanied almost simultaneously by other manifestations of general collapse. There are increased signs of general muscular weakness. If the patient was conscious previous to this change, he gradually ceases to show evidence of consciousness. The breathing becomes irregular and spasmodic. Any flushing which may have been present disappears, and is replaced by pallor, perhaps with a bluish or grayish tinge. Soon the breathing ceases entirely. The pulse becomes impalpable. During the earlier stages of this process, the heart sounds continue with less change than has been obvious in the pulse. But shortly after the pulse fails, the heart sounds also become faint and then cease. Usually, the breathing ceases slightly before the heart stops but the two changes are practically simultaneous. When the heart sounds and the movements of breathing have been absent for some minutes, no resuscitation is possible.

The mechanism of this final event seems to be connected with relaxation of the arteries, rather than with primary weakening of the heart. The condition seems to be somewhat analogous to that which occurs in fainting after exertion, and also in non-fatal surgical shock, in that all of these are best explained as resulting from loss of nervous control of the blood-pressure in the arteries. Thus, in most fatal diseases, the course of events seems to be that progressive exhaustion by the disease finally leads to failure in the central nervous system, causing a collapse of the circulation. The cessation of the heartbeat and of the breathing follow as consequences upon this collapse of the circulation and mark the termination of life.

CHAPTER XVII

INFECTIONS BY BACTERIA

Our knowledge of bacteria which has gradually developed during the past seventy-five years has contributed much to a fuller understanding of that most important branch of medical science which deals with the infections. Long before bacteria were known and classified, it was clear that certain diseases were transmissible; but it remained for bacteriology to reveal the process constituting contagion and the method by which it induced disease. Bacteriology not only furnished the explanation of many diseases, but in some instances it has provided practical measures for prompt and positive diagnosis, and for their more effectual prevention and treatment. If a physician of a century ago could see appendicitis (which he would have called peritonitis) nipped in the bud by aseptic surgery, or diphtheria controlled by antitoxin, and if he could see cities and armies kept practically free from typhoid fever, he would regard it as miraculous. These are but a few of the notable achievements attained through the lessons of bacteriology.

GENERAL BACTERIOLOGY

Bacteriology is still an apparent mystery to most people, probably for two reasons: (1) Since individual bacteria are so small that they are visible only through a high-powered microscope, many skeptics suspect that they do not exist; (2) many people who have heard about bacteria only in connection with disease fail to realize the numerous examples of bacterial action which are exemplified by the familiar, daily processes in the realm of nature.

Perhaps the best introduction to bacteriology is to point out that the essential elements of bakers' or brewers' yeast, and of the molds that grow on cheese or on jelly are bacterial in their nature. It is true that the yeasts and molds are somewhat more highly organized forms of life than are the simple bacteria. Nevertheless, a speck of mold growing on jelly has much the same appearance as a growth of bacteria upon the jellylike substance on which bacteria are planted and made to grow in laboratories. The speck of mold or of other bacterial growth is what is known as a "colony" of the bacteria, each of which is composed of millions of microscopic organisms, all formed by the division and multiple redivision of a single organism planted at that spot. Most bacterial colonies are more moist and muddy looking than the drier and more feathery colonies of mold, but both are the visible aggregations of microscopic bacterial bodies. Ordinary compressed yeast is composed of the living bodies of the yeast organism, together with some of the substance upon which they have been grown.

In quantity or collectively, therefore, bacteria are easily visible to the naked eye. A growth of the bacteria of typhoid fever or of those of tuberculosis, as seen in the glass container in which it has been cultivated by the bacteriologist, is a readily visible and harmless looking development upon the substance (called a culture medium) on which it was planted. The variety of bacteria may be determined by the gross appearance of the colony, but it is more definitely differentiated by microscopic study.

The most important general function of bacteria in the realm of nature is apparently the decomposition of all highly organized, organic matter so as to return it to the soil from whence it remotely originated. Bacteria do this by growing in the matter to be decomposed. Thus, while masses of bacteria in gross do not ordinarily appear in plain sight *per se,* they are present in enormous numbers in all decomposing substances. Rotting woods, decaying vegetables, and putrefying meat are alive with bacteria. It is an unusually clean and fresh specimen of unpasteurized milk that does not contain hundreds of living bacteria to each drop.[1] River water contaminated with sewage swarms with bacteria. As mentioned, the bulk of human and animal excrements is chiefly composed of the bodies of bacteria, and the growth of these in the intestine is a normal process.

Bacteria may appear and grow in any decomposable organic matter found in nature. It may be of interest to note that the canning of foods is a process the object of which is the destruction by heat of all bacteria in the food to be preserved, combined with a method of sealing to prevent the admission of any new bacteria. Smoking and salting of meats are chemical methods of preventing the growth of bacteria in order that bacterial decomposition shall not occur.

The organisms known as bacteria are therefore widespread in nature, and perform their unquestionably necessary function in her economy. The bacteria of disease are relatively few among the many other varieties which are harmless and useful. In fact, they are overcome by the more benign bacteria, as is illustrated by the "septic tank" treatment of sewage, by which, if the sewage is kept for a time, the dangerous bacteria, such as those of typhoid fever, are overcome by the innocent forms. Bacteriology is by no means a story of dreadful dangers; on the contrary, it contains more that is necessary and beneficial.

As revealed by the microscope, individual bacteria are minute bodies of different shapes. But here again, as with the gross appearance of their colonies, their mere appearance gives little hint of their effects. They are single-celled organisms so low in the scale of life that it is debated whether they are best classified as vegetable or as animal; they seem to be so primitive as scarcely to belong to either group. While usually rated as vegetable, certain of the more highly specialized forms have characteristics more suggestive of primitive animal life.

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[1] In the tests of milk constantly performed in public health laboratories, one hundred thousand bacteria per cubic centimeter is considered the limit of safety beyond which the milk is condemned.

Some bacteria are round, and these are called *micrococci;* some are elongated, like a hyphen, and these are called *bacilli;* others are spiral, and are called *spirilla;* a few have waving tails or cuttlefish-like processes, called flagella, and by the use of these extensions they are capable of independent swimming movements.

Some bacteria arrange themselves characteristically with reference to each other, as in pairs or in chains. An important class of micrococci that appear in series, like strings of beads, are known as *streptococci* because of this tendency.

For exact study, bacteria are stained by various dyes and, by means of their particular reactions to special staining methods, individual characteristics are revealed by which their differentiation is possible.

Thus, by the gross appearance of bacterial colonies upon various substances as media, by their microscopic structure, by their reactions to particular stains, and by other applied tests, it is possible to differentiate many varieties of bacteria, some of which are connected with individual diseases.

BACTERIOLOGY OF DISEASE

Three facts are essential to prove that certain bacteria are the cause of any disease: (1) They must be found in every instance of the disease; (2) when separated from other bacteria and injected into animals they must produce the same disease; and (3) the same variety of bacteria must be recovered and isolated from the disease so produced in animals. Through such tests it is frequently demonstrable that certain bacteria are the cause and the only cause of a particular disease. In some diseases the chain of evidence to incriminate the bacteria found in connection with them is not so complete, since many diseases common to the human host cannot occur in animals; but in many of these it is still so strong that there is little doubt of the causative connection. In still other diseases which behave like infections, the specific bacteria are yet unknown, but measures based upon the assumption that they are of bacterial origin have succeeded in limiting their incidence.

Sources of Infection.—The manner in which disease-producing bacteria gain entrance to the body to cause disease deserves special attention. Their sources are various, and include: (1) the bodies of other persons or in some instances of animals; (2) other less vulnerable parts of the body, such as the fingers of the person attacked; and (3) non-human sources, such as water, milk, and meat.

The bacteria which cause infection and inflammation in wounds are more or less prevalent upon normal skin, as of the hands, in clothing, and upon instruments that have been handled. In introducing students to bacteriology, it is a common practice to have them wipe a wire over the hands and then over material in a glass tube upon which bacteria will grow, having first rendered it free from the bacteria by heating in a flame and then cooling it without contact. Unless the hands have just been thoroughly washed, colonies of bacteria will be found next day along the track of the wire. And by the conditions of the experiment these colonies can have developed only from bacteria carried by the wire from the skin of the hands.

The development of modern surgery is due to recognition of the fact that the infection of wounds comes from without, and the resultant measures to remove bacteria from surgeons' hands, from instruments, and from the patients' skin.

The mouth, throat, and intestinal tract of each individual contain many bacteria, some of which may be of such character as to cause disease under particular circumstances, either in their original host or in others. Diseased tonsils are believed to be an important avenue by which bacteria of the mouth gain admission to the body and are transmitted to distant structures.

As to the origin of infection in individual cases, diseased individuals are most likely to be the source of the infection acquired by others, but there are instances in which persons who have recovered from the disease harbor its bacteria for long periods. Thus, while perfectly well, they nevertheless constitute a danger to other people. Such individuals are known as *carriers*.

Modes of Transmission.—There are two ways in which bacteria are communicated from an ill person or a carrier to one who is well: (1) directly, of which kissing is the readiest illustration, but which is also possible by less obvious contact; and (2) indirectly, in several ways, that is, by communication through the air, sometimes called "droplet transmission," which undoubtedly occurs in diseases in which coughing and sneezing are factors; by an unwashed drinking cup or other unclean dishes previously used by a carrier; and by transmission through other indirect sequences of contact. These may be more complicated in their chain of events, as in the following illustration. A person "coming down" with diphtheria coughs with his hand held before his mouth, and then opens a door by turning the knob; another person opens the same door and subsequently, without washing his hands, picks up some food and eats it. By such sequences of indirect contact, bacilli of diphtheria may be transmitted from one person's throat to that of another.

Milk, water, and foods figure largely as vehicles in the indirect transmission of disease. A generation ago, public water supplies of many cities were polluted with typhoid bacilli. Milk, and the ice cream made from it, have transmitted diseases in many epidemics. In some instances the milk has become contaminated by a dairy worker; in others the disease has originated from a cow. Kitchen workers whose hands become contaminated from their discharges may infect food and become typhoid carriers.

Flies may transmit bacteria.[2] Particularly in unscreened country privies without plumbing, flies have access to fecal matter which may contain typhoid bacilli. They may then fly to the kitchen and alight on food. Tubercle bacilli have been demonstrated in the "specks" of flies that have fed on the sputum of those with tuberculosis.

Effects of Infection.—When bacteria gain admission to the body, by any method, the result depends upon the variety of the bacteria and the particular susceptibility of the host. If the person has developed an immunity to the disease in consequence of a previous attack, there is no untoward result. Otherwise, the bacteria feed on the host and multiply in the body, much as they do if planted on some culture medium in a laboratory, with the result that symptoms of the disease follow.

The harmful effects produced by the bacteria of disease upon the human body depend largely upon the fact that the growth of bacteria is accompanied by the production of deleterious or poisonous substances, known as *toxins*. If an orange becomes moldy in one spot, a moldy taste soon pervades the whole orange. The substance that produces this taste may well be compared with the poisons evolved in the growth of the bacteria of disease. These poisonous substances have two effects, their relative importance differing in various infections. One effect is to produce inflammation in the region where the bacteria are growing; the other is to cause fever and other systemic reactions, sometimes accompanied with but little local inflammation. An illustration of local inflammation without general symptoms is a boil of the skin, or a small wound with local infection. Diphtheria, and tetanus or lockjaw are instances of disease with relatively insignificant local inflammation but with disproportionately serious systemic effects from the absorption of poisonous products.

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[2] The stress heretofore laid upon foul odors as disease producers is due to the fact that they usually emanate from open, contaminated areas from which migrating flies also escape. Similarly, the night air over tropical swamps which was formerly thought to carry yellow fever and malaria is now known to be harmful only because it harbors the mosquitoes that breed in such swamps.

The body has natural defense reactions against these two attacking forces. As already mentioned, inflammation represents the reaction against local infection, by increased blood supply, by increase of tissue fluids, and, probably most important, by the assembling of cells called leukocytes. When an abscess is formed and its contents are discharged, the bacteria are eliminated in the pus.

Systemic poisons or toxins are either contained in the bodies of the bacteria, or are separable from them; but the blood and body fluids gradually develop defensive or neutralizing substances of an obscure chemical nature to resist them. Recovery from infections with systemic symptoms apparently represents the result of such resistance by these natural, neutralizing substances against the toxic products formed from the bacteria, or formed from the tissues by the bacteria. The cessation of active symptoms in certain diseases may be compared with the reversal of reaction in an acid solution which occurs when an alkali is gradually added to it.

The toxin of diphtheria is best known, since it can be prepared artificially and separated from its bacteria; in this disease the neutralizing substance in the blood is called *antitoxin.* By treating horses with increasing amounts of diphtheria toxin, their blood develops large amounts of antitoxin; and, in cases of diphtheria, the injection into the body of the patient of the blood-serum obtained from such horses has striking effects in overcoming the disease.

Similar treatments have been developed for other diseases, some with a considerable degree of success, others without conclusively proved beneficial results; all of these are generally referred to as *serum treatments.*

Antitoxin is used also to prevent diphtheria in persons who have been exposed to it, as well as in actual treatment of the disease. A similar serum treatment is used to prevent tetanus or lockjaw after wounds.

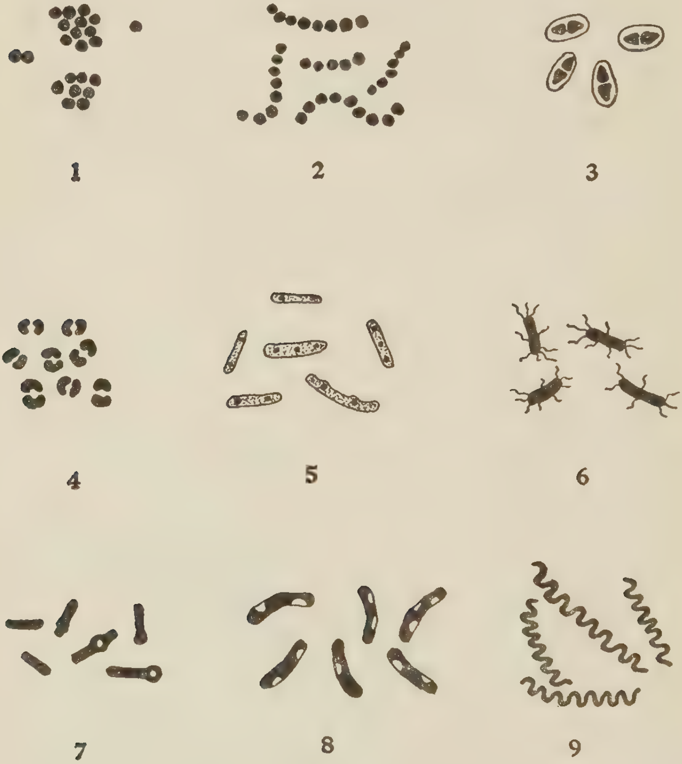

Fig. 27.—Varieties of bacteria

1, staphylococci, in clumps. 2, streptococci, in chains. 3, pneumococci (of pneumonia). 4, gonococci (of gonorrhea). 5, diphtheria bacilli. 6, typhoid bacilli, showing flagella. 7, tetanus bacilli, with tendency to "drumstick" forms. 8, tubercle bacilli, showing "moth-eaten" appearance. 9, *Spirochœta pallida* of syphilis.

Immunization against various diseases is produced in another and more lasting way by injecting minute amounts either of toxins of bacteria or of bacteria themselves which have been killed by intense heat. The effectual immunization against typhoid fever belongs to the latter group.

IMPORTANT BACTERIA OF DISEASE

The following list includes the classes and individual varieties of the most important bacteria which cause disease in man, together with certain noteworthy facts about them.

I. *Micrococci.*—The micrococci are bacteria which are round or nearly round. A number of varieties are classified under this general name, and there are undoubtedly more varieties than have yet been differentiated. They are divided into the following subordinate groups:

Staphylococci. These are spherical organisms of several types, having a common tendency to arrange themselves in clumps or bunches. They are frequent causes of pimples and of boils, and, rarely, of serious internal infections.

Streptococci. These are micrococci which multiply in a chain-like arrangement. They are the chief organisms found in infected wounds and in many internal infections, for the most part suppurations, ranging from tonsillitis to empyema and peritonitis. Other types are the cause of carbuncle, of erysipelas, and of scarlet fever.

Pneumococci. These are slightly pointed or pear-shaped organisms, arranged base to base in pairs. Four varieties have been isolated but all are causes of pneumonia in different cases. They also produce less serious infections, as of the eye, of the nose, or of the windpipe (trachea), with the manifestations of the common cold. It is disputed whether the pneumococci of disease are ever found in normal throats.

Meningococci. These are paired, kidney-shaped organisms which are present in the fluid surrounding the brain and spinal cord in epidemic meningitis. They are frequently found in the throats of well persons.

Gonococci. These resemble meningococci in form but are not otherwise related. They are the cause of purulent inflammation of the mucous membranes of the genital tracts, both male and female. After acute symptoms have ceased they continue to be present for long periods. They may also attack the eye, both in adults and in newborn infants.

II. *Bacilli.*—Bacilli are elongated bacteria, shaped like a hyphen or dash, being three to ten or more times as long as they are thick. These rodlike organisms may be straight or somewhat curved.

Diphtheria Bacillus. This is a bacillus of average size having a dot at each end and sometimes a third dot in the center. It grows readily when a cotton-tipped applicator is first touched to the throat of a patient with diphtheria and is then drawn over the surface of a proper culture medium. Such cultures are the proof by which suspected diphtheria is demonstrated. The bacilli remain in the nose and throat for a variable time after a patient has recovered from diphtheria. While diphtheria bacilli may usually be recognized with certainty, there are other rare bacilli which are occasionally difficult to differentiate from true diphtheria bacilli.

Typhoid Bacilli. These organisms are rather long bacilli which, when examined alive in liquid media, are seen to be in active motion. By special staining methods they show wavy, threadlike flagella extending from their bodies. Early in an attack of typhoid fever they may be grown or cultivated from the patient's blood, and so confirm the diagnosis. Later in the course of the disease, and sometimes after recovery, they are present in the stools and in the urine.

The blood-serum of a patient who has or has had typhoid fever[3] will cause typhoid bacilli in a liquid medium to cease their motion and to gather together in motionless clumps, whereas normal blood-serum does not have this effect. This clumping is called agglutination, or *agglutination reaction.* Such agglutination reactions may also occur between other bacteria and the blood-serum in the disease that they cause. In cases of suspected typhoid fever, in which it has not been possible to confirm the diagnosis by recovering the bacilli from the blood, a test based on the agglutination reaction has been devised to determine the presence of the disease. If the blood-serum of the patient is found to agglutinate known typhoid bacilli which are kept in the laboratory, the suspicion of typhoid fever is practically confirmed. This is known as the *Widal test.*[4]

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[3] The blood-serum of persons who have been made immune to typhoid fever by preventive injections will also agglutinate the bacilli.

If the bodies of typhoid bacilli which have been killed by heat are injected into the human body, the person so treated becomes immune to typhoid fever. The natural protective forces seem to develop in the same way as if the person had suffered an attack of the disease. Such immunization or *vaccination* has been conspicuously successful in the prevention of typhoid fever. The use of so-called vaccines of killed bacteria has apparently been of some value in the prevention of some other diseases, but many attempts to apply this principle have not resulted in appreciable benefit.

Colon Bacilli. These are normal inhabitants of the intestinal tract. While they bear some resemblance to typhoid bacilli, they have certain characteristics which serve to differentiate them. In the intestine they are harmless, but if, through wounds or disease, they escape into the peritoneal cavity they may induce peritonitis. Sometimes they are a causative factor in infections of the urinary tract.

Tubercle Bacilli. The bacillus of tuberculosis differs radically from the organisms thus far described by the extreme slowness of its growth. While planted colonies of ordinary bacteria show visible growth within twenty-four hours, it takes weeks for colonies of tubercle bacilli to grow large enough to be seen. The gradual course of tuberculosis, as compared with other diseases, is undoubtedly related to this fact. Microscopically, the tubercle bacillus is a curved and beaded organism, readily differentiated through its peculiar reaction to a certain method of staining. It is found in sputum among the cells of chronic inflammation which result from tuberculous processes of the lungs. The presence of tubercle bacilli in sputum is the confirmatory test which proves the existence of pulmonary tuberculosis.

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[4] Agglutination reactions are also of use in identifying unknown bacteria. If a blood-serum which can agglutinate cultures of a known organism is likewise found to agglutinate cultures of an unknown organism, it becomes highly probable that the two organisms are the same; but if, on the contrary, the unknown organism is not agglutinated, it is necessarily of different identity.

Tubercle bacilli in the sputum are also an indication that the patient is a source of danger to others, particularly to children, since there is reason to believe that most tuberculosis is really contracted in childhood even though its pronounced symptoms may not appear until adult life. The necessity of destroying sputum is obvious. Other methods of transmitting the disease should also be recognized and appropriately prevented, that is, droplet communication by coughing, and contact transmission by kissing or by the hand held before the mouth in coughing. Theoretically, transmission by flies is possible if the sputum is not destroyed.

The milk of tuberculous cows may contain tubercle bacilli. While the relative danger of these bacilli to man has not yet been exactly determined, there is increasing reason to fear them. Medical authorities have stated that about one-fourth of the tuberculosis of childhood is probably attributable to milk. Carefully pasteurized milk is free from this danger. In so-called certified milk, the danger is much reduced but not entirely eliminated.

Tetanus Bacillus. This organism causes a disease of rather infrequent occurrence, but it is mentioned here in preference to other organisms which cause more frequent diseases because it is the most important example of anaërobic bacteria. The word *anaërobic* means not living in air; bacteria such as the tetanus or lockjaw organism can grow only when they are not exposed to air. The tetanus bacillus is generally prevalent

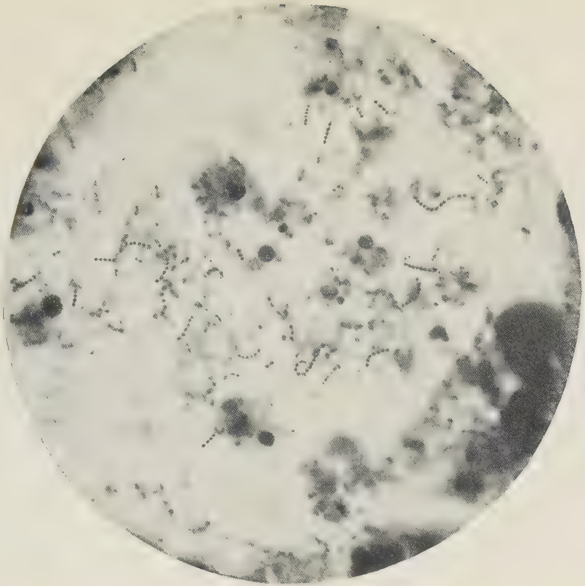

FIG. 28.—STREPTOCOCCI IN TISSUE

As seen in the actual stained preparation the bead-like bacteria are a deep blue against a pink background. (Slightly retouched.)

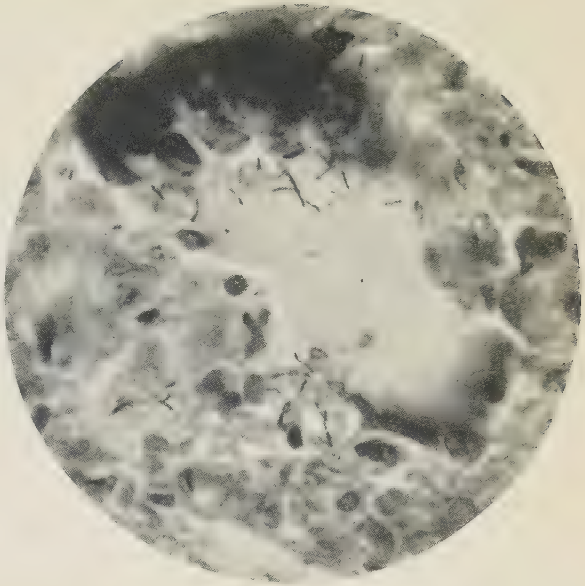

FIG. 29.—TUBERCLE BACILLI IN TISSUE

The black hyphen-like lines are the bacilli. In the original preparation the method of staining gives them a ruby-red color in contrast to the blue background. This contrast is lost in the photomicrograph.

in soil, and produces the disease called lockjaw when dirty foreign material is carried deep into the tissues by penetrating wounds and remains there.

III. *Spirilla.*—Spiral bacteria are not causes of familiar diseases save for certain organisms which differ from true bacteria in that they approximate microscopic animal parasites. But since the two most important ones are directly transmissible from one person to another, just as bacteria are transmitted, they will be described here rather than among the animal parasites.

The Spirochœte of Syphilis. This organism has the appearance of a minute corkscrew, and when alive it has independent motion. It is found in the early lesions of the disease, and also in those which develop in the mouth during the second half of the first year of the disease. Drying is soon fatal to these organisms so that they are transmissible only by direct contact, or by rapid, indirect contact in the course of which drying has not occurred.

The Spirillum of Vincent. In a certain form of ulceration in the mouth or throat known as *Vincent's angina,* a spirillum and a pointed bacillus are found in combination. Apparently, it is necessary for both of these organisms to be present simultaneously to produce the disease.

IV. *Higher Bacteria and Fungi, Molds and Yeasts.*—The higher bacteria differ from the simple varieties in their more evident internal structure and also in their tendency to bud and to branch into more complex formations. An example is the so-called ray fungus, which forms in rosettes visible to the naked eye. It is the cause of a disease in cattle called *lumpy jaw* and of the rare condition in man known as *actinomycosis.*

Parasitic fungi are the causes of many diseases of the skin, such as that known by the misnomer "ringworm."

MICROSCOPIC ANIMAL PARASITES OF DISEASE

Disease may also be caused by certain low forms of animal life of the order of the amœbæ, by some non-bacterial forms of uncertain nature, by certain larvæ, and also by adult forms of larger animal parasites. A number of these are transmitted from man to man only by biting insects. Such transmission is not a simple transference of the parasites, but each parasite must necessarily pass through a certain stage of its life within some special variety of a particular insect.

The parasites of the various forms of *malaria* are significant examples. These are microscopic bodies more like amœbæ than like bacteria, and are carried only by mosquitos of the anopheles order. In the human host, to whom they are transferred by the bite of the mosquito, they enter the red blood-corpuscles and develop there. In the most frequent variety of malaria, called *tertian malaria,* a new crop of parasites matures every forty-eight hours. As the parasites burst from the red corpuscles the patient has a chill and fever, probably caused by the liberation of some biochemical substance.

Yellow fever and *dengue fever* in the tropics are similarly transmitted by mosquitoes; *typhus fever, trench fever,* and *relapsing fever* by the body louse; *Rocky Mountain fever* is spread by ticks; *African sleeping sickness* is transmitted by a biting fly.

Trichinosis is a parasitic disease not carried by an insect but contracted by eating uncooked "measly" pork. The larvæ of the parasite of the hog migrate into the muscles of the human host where they may be found; microscopically, they resemble coiled worms.

The amœbæ of *amœbic dysentery,* which produces ulcers in the large intestine, are probably ingested in drinking water. They are present in the intestinal discharges of persons who have or have had the disease, and may be transmitted by carriers.

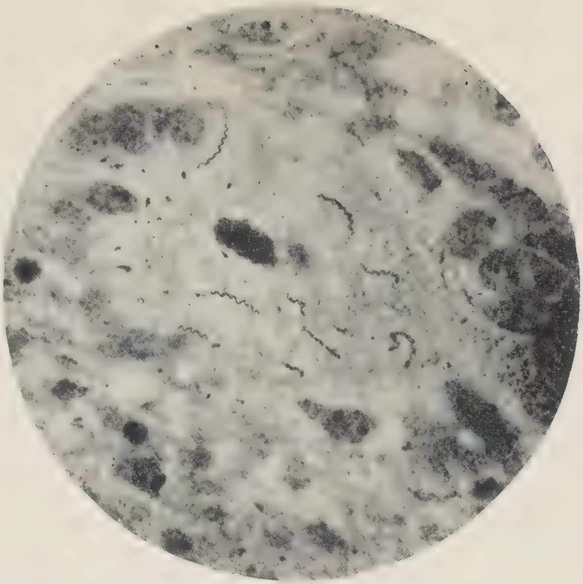

FIG. 30.—SPIROCHÆTES OF SYPHILIS IN TISSUE

(Slightly retouched.)

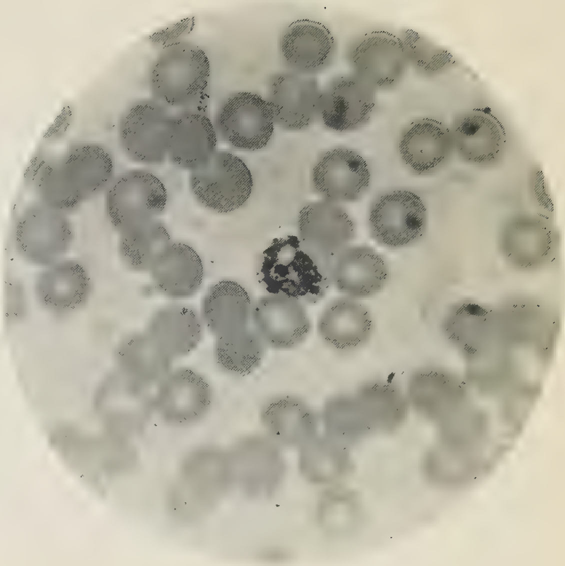

FIG. 31.—MALARIA ORGANISM IN THE BLOOD

In the stained preparation, it is made conspicuous by containing one or more brilliant red spots within its otherwise blue body. The staining also makes plain that it is contained within a red corpuscle.

Certain wormlike parasites of variable size but visible to the naked eye sometimes gain entrance to the intestinal tract and grow there indefinitely—the pinworms of children for example; tapeworms, in contrast, may attain a length of twenty feet and more. While the consequences of these are not serious, the hookworms of our southern states have more significant effects upon the general health.

INFECTIONS THEORETICALLY ASSUMED BUT NOT IDENTIFIED

Many diseases exist which are transmitted in the same manner and behave similarly to known infections, but of which as yet no differentiated organism has been isolated. *Smallpox, chicken-pox, mumps,* and *measles* are examples. It is suspected that in some diseases the causative organisms are too small to be visible, since fluids capable of producing the diseases in animals still retain this power after they have passed through porcelain filters so fine that the smallest bacteria visible with our present microscopes cannot pass through them. This subject is still an active field for medical research.

CHAPTER XVIII

DIAGNOSIS, OR METHODS OF RECOGNIZING PARTICULAR DISEASES IN INDIVIDUAL CASES

When a person is ill, the methods by which a physician differentiates the disease are various. The subject is a complicated one of which only a brief sketch can be given.

DIAGNOSIS

The evidence is gathered from the following sources:

1. The history, which is the patient's account of his symptoms from their beginning to the time of the examination. This, interpreted in the light of the doctor's knowledge of the symptoms of various diseases, serves to focus attention upon the chief possibilities, and may sometimes give positive clues. The history also takes account of previous illnesses and of family history, which may have some bearing upon the existing condition.

2. Physical examination, or what the physician observes objectively. What he sees, feels, hears, or in some instances what he smells may reveal significant information. Other aspects of the examination, on the other hand, may be detected and judged only after long training and wide experience. The highly developed sense of touch which perceives abnormal conditions within the abdomen by palpation or feeling, and the ability to draw correct conclusions from variations in the sounds heard over the heart or lungs are not easily described, but are important phases of the preparation for the practice of medicine. Through such methods it is possible to determine the solidification of a part of a lung in pneumonia, or impairment of a certain valve of the heart, as well as many other

abnormalities which are neither visible nor palpable. Diagnosis by means of physical examination has been developed through the combined experience of the medical profession, which has demonstrated by post-mortem examination that each recognized departure from normal, objective findings is evidence of a certain departure from normal in the internal condition of the body.

More complicated still are the instrumental methods by which hidden structures of the body become visible, such as the interior of the eye, the larynx, and the interior of the bladder. The X-ray has important functions in examination of the body, although attention may be directed to the fact that at present the laity is inclined to expect more of X-ray examinations than is warranted by the actual attainments.

3. Laboratory examinations. The urine, the blood, the sputum, the stools, and other substances obtained from the body may be subjected to numerous tests which give evidence of the presence of disease. These tests may be chemical, microscopial, or bacteriological, and may be either quite simple or exceedingly complex.

4. Continued observation, to determine the progressive changes that occur after the first examination. A method of diagnosis which is sometimes resorted to, when the conditions suggested are serious enough to warrant it, is the so-called exploratory operation.

Sometimes diagnosis is a simple matter, the conclusion being established beyond dispute by some single sign, such as the characteristic rash of measles, or the finding of malarial parasites in the blood, or of tubercle bacilli in the sputum. More frequently, however, conclusions are reached only by weighing all of the evidence, that which supports each possibility as well as that which is more or less inconsistent with its presence. In most diseases, no single sign, or simple combination of signs, has yet been established to give positive proof of its existence. Thus, diagnosis in the less obvious cases calls for highly developed judgment, and for deliberate consideration of many facts.

THE DIAGNOSTICIAN

Through past ages, and to some extent even now, the popular mind has cherished the ideal conception of a doctor who could tell at a glance with infallible accuracy just what was the difficulty in each case. While it is needless to say that this ideal has never been realized completely, the diagnostic aids and methods of the present-day physician are highly developed. The doctor of a century ago could make a positive diagnosis in comparatively few diseases. The modern diagnostician has ways of detecting such abnormalities as may exist in practically all parts of the body, which enable him in most cases to arrive at definite conclusions.

Certain diseases may be positively determined, without the least possibility of error. This is achieved by scientific tests, and by an ability to observe things which are of medical significance but which an untrained person would not notice. The conclusions reached by either of these methods may well seem to the laity to approach magic.

On the other hand, there are many cases which no doctor in the world can diagnose with absolute certainty, and in such instances different physicians will lean toward opposite opinions. Modern science has added much evidence through which uncertainties are diminished. On the other hand, the numerous diagnostic criteria available by modern methods has rendered present-day diagnosis enormously more complex. It must therefore be freely admitted that the diagnosis of many conditions is still inevitably subject to some fallibility.

This being the case, there is also some uncertainty as to the proper course. When the diagnosis is beyond doubt the treatment follows almost automatically, varying only according to individual characteristics of the patient. In instances in which a diagnosis is probable, but in which there exists an alternative possibility of some other disease, the treatment is directed against the probable disease, but precautions must be observed not to prescribe treatment inappropriate to the other suspected condition.

Unfortunately, there are sometimes cases in which the impossibility of absolute diagnosis results in an actual dilemma. Two possibilities exist which are indistinguishable, and the treatment of one is diametrically opposed to the treatment of the other. Perhaps the readiest illustration of such a situation is that of abdominal attacks which may be either acute appendicitis requiring operation, or, a condition such as food poisoning or pneumonia, in which the operation would be unnecessary or harmful. There are cases of this kind in which no medical authority can give a positive and absolutely reliable opinion. In such situations all the available evidence is considered and the physician advises the course which, in his best judgment, is the safest one to pursue. And he must make a positive decision in spite of a conscious realization that his best judgment may prove subsequently to have been wrong. If he recommends surgical interference it may produce serious consequences; if nothing is done more harm may result, although the physician will perhaps be less likely to be censured. The laity should understand that in many conditions the most experienced can offer advice based only upon the present medical knowledge, with no assurance that it will prove correct.

The expectation of infallibility and the failure of physicians to attain it have been the basis of much misunderstanding between the laity and the medical profession. The layman resents any decision which subsequent events prove to have been erroneous, and can scarcely be persuaded that the physician who made this decision is not totally incompetent. Conversely, the medical profession resents the criticism of its members by persons who are unable to appreciate that the errors in diagnosis are actually due to the present limitations of medical science. High feeling frequently develops as the result of which many physicians in limited communities have undeservedly lost standing and many laymen have developed a hostile attitude toward medicine.[1]

A more wholesome situation would be established if the laity would regard the doctor, not as a magician or an oracle, but as one who by special knowledge and experience in medical matters is fitted to give advice as to the wisest course to pursue when confronted with accident or disease.

A lawyer is not expected to predict infallibly how a case will appeal to a jury, nor a financial adviser to prophesy with any certainty the future of the stock market, and neither is severely criticized if, after recommending the course which at the time seemed the best, it becomes evident subsequently that another would have been better. Similarly, in health matters the doctor should be regarded as an adviser and not as a prophet.

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[1] The many instances in which a doctor is praised by the public beyond his deserts do little to improve matters in this respect. Overpraise, frequent as it is, gives little real satisfaction, while undeserved censure cannot readily be accepted philosophically.

CHAPTER XIX

THERAPEUTICS, OR METHODS OF TREATMENT

TREATMENT, preventive and remedial, is the chief end of all medicine. The physician's understanding of the medical sciences and his ability to make accurate diagnoses have as their chief, practical object the decision as to what treatment shall be instituted. The patient who consults a doctor seeks information as to the meaning of his symptoms and their possible effect upon his future, but he wishes still more to be told what to do in order that he may become as well as possible with the least delay. The methods of diagnosis are of interest to him only in so far as they promote this end, and even the conclusions as to his condition concern him less than the directions as to what he shall do to get well.[1]

In a survey of medical matters, it is therefore important to obtain a clear insight into what constitutes the various forms of medical treatment. Some of the methods of attack in particular diseases will be described elsewhere, but here it is desirable to discuss general principles.

There is also much popular misunderstanding with regard to what the physician can do in the way of treatment. In their attitude toward medical treatment, people tend to fall into three more or less distinct groups.

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[1] It may be mentioned that doctors often fail to appreciate this fact, and as a result they may fall short of giving complete satisfaction. In the physician's work it is the diagnosis in each case which plays the more prominent rôle and furnishes the greater opportunity for skill and acumen. To obtain a medical understanding of the particular situation is to him the most important aspect of the problem. When this is attained, the treatment follows according to established principles; and unless some unusual surgical operation or some special procedure is included there is little scope for originality on his part. Consequently, the physician may easily fail to show enthusiasm in prescribing it. This may explain but not excuse a frequent basis of complaint.

1. Probably a large majority of the laity recognize that their ability fully to understand the conditions is limited. Therefore, they place full responsibility upon the physician and accept his decisions with confidence. This represents the normal and wholesome attitude. If the patient's understanding of the doctor's course is better than it usually is, a fuller degree of coöperation is possible; but the doctor should be in complete control of the management.

2. A certain proportion of the laity, on the other hand, have little or no faith in doctors, and so call for medical assistance unwillingly, or tardily, or not at all. While in many instances nature's treatment is sufficient for a satisfactory result, there are others in which neglect proves costly, and results in unnecessary risk, in possible prolongation of the illness, and in needless suffering. Some of the most regrettable disasters are due to the fact that a doctor has not been called until a condition has passed its curable stage. It is to be hoped that readers of these pages will find in them sufficient evidence that such an attitude is unwise.

3. A third group of persons is comprised of those who hold exaggerated beliefs of what medical treatment may be expected to accomplish. For the most part, these represent persons who are still influenced by the age-old confusion between medicine and magic. While faith in incantations no longer exists,[2] the expectation of fancied dramatic benefits from unknown drugs or from mysterious procedures still flourishes. Persons of this tendency are disappointed if they are not given frequent doses of many medicines, and suspect that a doctor who does not prescribe them is incompetent. While most of these persons, like the skeptical group, are deficient in knowledge and judgment, there is a modern element in this class composed of "intellectuals" who have read glowing articles upon certain conspicuous medical advances, and so expect all branches of

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[2] Except as represented in Couéism and Eddyism, and similar systems designed to influence the mental attitude.

medicine to be on the same elevated plane. Unfortunately, no such general progress has been attained.

In the broadest sense medical treatment includes all indicated remedial measures to be adopted, as well as the necessary precautions against harmful procedures, to favor recovery or improvement. Obviously, they are of many kinds and vary in importance.

For the prevention and alleviation of certain diseases there are specific measures which may be classified as directly and effectually preventive and curative. However, in only a small minority of disorders may treatment be regarded as direct intervention against the disease. It is true that today there are more direct measures than were available a generation ago, but they are still the exception rather than the rule. In the majority of disorders, treatment does little or nothing to remove the disease. It is directed toward supporting the patient until the natural body processes effect its subsidence. Thus, in most instances the doctor sees to it that all possible effectual measures are applied, and that unfavorable influences are removed so far as possible, but his activity is that of judicious guidance rather than radical intervention, careful planning rather than the administration of a specific cure.

It should not be inferred, however, that medical treatment is to be undervalued. To learn that there is not a sovereign remedy for every disease will no doubt diminish the interest of some, but nevertheless there remains much of great importance which can be done in the way of supportive treatment and the circumvention of complications. Although less spectacular, it is true that most treatment consists of attention to a multiplicity of details, some of which may seem trivial; but the fact to be emphasized is that the sum total of such attention may be the deciding factor in the outcome. The pitiable and dangerous results of disease in which no treatment has been available are clearly demonstrated among refugees or dwellers in remote places. Aside from diminishing the danger of death, medical treatment tends to limit absence from occupation, and to provide relief from pronounced pain or discomfort.

Methods of treatment may be classified in certain groups.

SURGICAL MEASURES

Of all methods, surgical procedures are the most dramatic and in some instances the most directly curative. If, in a case of appendicitis, the surgeon promptly removes the diseased appendix and sutures the operative wound, the patient and the disease have parted company, and there remains only a surgical wound to heal. Similarly, a diseased gall bladder or an early cancer of the lip may be eradicated. Gallstones and kidney stones may be removed. In internal abscesses and other suppurative processes such as empyema and peritonitis, in which spontaneous recovery almost never occurs, surgical drainage results in a large proportion of cures. Moreover, only the practical difficulties of providing adequate drainage of pus from concealed and inaccessible abscesses prevent the method from being successful in all suppurations. For success, surgical methods require accurate diagnosis and skillful execution, but in such conditions in which they are applicable they are the physician's most conspicuous success in modifying, by active intervention, the bodily processes of nature.

X-RAY AND RADIUM TREATMENT OF TUMORS

In recent years much attention has been devoted to the use of X-ray and radium in malignant tumors. The laity has viewed this research hopefully because of the natural desire to avoid surgery, and there is a widespread impression that such treatments have been productive of results which as a matter of fact they have not accomplished. The basic theory of this therapeutic measure is that X-ray and radium are agents capable of burning or destroying tumor tissue when administered in "doses" or exposures that do not injure normal tissues. Thus, it is assumed that these rays may be used as a substitute for surgical removal of the new growths. But the practical application of this method has fallen short of perfection. In some surface tumors, X-ray or radium treatment is curative if applied very early in the course of the disease. But the unfortunate characteristic of cancerous growths is their invisible extension far beyond the apparent limit of the tumor; and in internal cancers it is usually not possible to effect destruction of the new growth by X-rays or radium with the same degree of safety, thoroughness, and success as this can be achieved by surgery. Besides, radiation treatment of serious cases is more painful than operative procedure. Therefore, it cannot yet replace surgery. It is of value, however, in supplementing surgery in cases in which additional treatment is desirable, when it is doubtful whether the tumor has been successfully removed; it is also of distinct service in retarding the growth of a tumor when there is no hope of an actual cure. The subject of cancer is still largely confined to conjecture, and radiation, which has not yet revolutionized the situation, remains a fertile field for investigation.

Fibroids of the uterus which are not malignant tumors may be markedly affected by the X-ray. For large fibroids, however, surgical treatment is usually preferable, as there are certain disadvantages and dangers in radiation.

SERUM TREATMENTS

Serum therapy also represents active intervention as opposed to passive acceptance of natural processes. The basic theory of such treatment is the administration, to those who have a disease, of some of the natural substance that overcomes the disease to which the individual is subject. Thus, the natural curative substance, which the body processes of a given patient may be unable to produce in sufficient quantity, is supplied or supplemented by administering some of the same substance obtained from specially treated animals, or from human beings who have had the disease. The treatment and prevention of diphtheria by its antitoxin is the most conspicuous illustration. The serum used to counteract meningitis is likewise of decided benefit. In tetanus, serum is effectual as a prophylactic but less so as a therapeutic measure. Whether the serum treatment of pneumonia, as so far developed, is of definite value is still uncertain, although something has been accomplished. Recently a serum has been developed against scarlet fever. There are also sera for certain less familiar diseases, such as bacillary dysentery and anthrax.

Serum therapy is applicable only in dangerous or obstinate diseases, since its use is frequently followed by various reactions such as itching eruptions and joint pains. But it is to the credit of modern medicine that serum treatments have been instrumental in saving untold lives, particularly in diphtheria and meningitis, and in the prevention of tetanus from war wounds.

PROTECTIVE INOCULATIONS AND VACCINE TREATMENTS

Vaccinations and inoculations differ from serum treatments in this respect: a serum is a fluid containing the active principle which combats the disease; a vaccine, on the contrary, is a product containing the substance which causes the disease, and is administered with the object of arousing the body to muster its natural forces to combat the disease—or in other words to develop its own curative serum. The decisive successes of inoculations and vaccine treatments have been practically confined to prophylaxis, but in this direction the control of smallpox and the nearly complete elimination of typhoid fever from armies must be recognized as great benefits.

Vaccination against smallpox is a remarkable achievement in the history of medicine, and may be regarded as the most far-reaching instance in which human intelligence has improved the welfare of mankind with respect to disease. Before vaccination was known, smallpox was widespread by reason of its extreme transmissibility. Now its occurrence is rare, and vaccinated persons exposed to the disease do not contract it. Absolute protection is afforded by a recent, successful vaccination. Today, the only danger in relation to smallpox lies in the threatened relaxation of the practice of vaccination, a subject which will be enlarged upon subsequently.[3]

The process of vaccination against smallpox, however, occupies a unique position in prophylaxis. It represents a utilization of the accidentally discovered fact that, if a person has been infected with cowpox, immunity to smallpox results. Thus, vaccination is conveying of cowpox by means of a living virus.

The other protective measures called vaccine treatments which have been developed in recent years differ from this, in that they depend upon the injection of the bodies of killed bacteria of known varieties, instead of upon the planting of a living virus whose organism has not been isolated. The preventive inoculation against typhoid fever, already mentioned, is an illustration of the use of killed bacteria to create an immunity to a bacterial disease.

SPECIFIC CHEMICAL AND DRUG TREATMENTS

There are some diseases in which specific drugs or chemical treatments produce a directly combative effect. Some, like the use of quinine for malaria, have been known for a long time; others, such as the recently developed arsenical compounds against syphilis, belong to the modern advances. Many attempts to devise new treatments of this order are still in progress.

For most diseases, however, there is no specific. This is a truth which bears repetition. The mystic remedies of past ages, like the alchemists' attempts to turn dross into gold, had no sound foundation. The household remedies of our grandmothers were for the most part without real effects. In the past century the advent of science has done much to trace the true actions of drugs, with the result that relatively few of the older ones may be regarded as having direct or specific curative effects.

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[3] See section on Smallpox and Vaccination in chapter entitled Infections, p. 234.

ANTISEPTICS

The discovery of the rôle of bacteria and parasites in the causation of disease naturally directed attention to chemical antiseptics, because it was believed that agents which could kill bacteria outside of the body should prove effective in bacterial diseases. But this too has resulted in widespread misconception. The truth is that in most infections the bacteria are so imbedded in the tissues that they cannot readily be reached by antiseptics, and furthermore, that antiseptics which kill bacteria in tissues are much more likely to injure or destroy the tissues. Energetic attempts to treat infections with strong antiseptics are sometimes made by medical students upon themselves, and usually produce injurious results. While in certain open wounds cleansing with mild antiseptics may be of value, the modern tendency is to cleanse with bacteria-free solutions, rather than with chemical antiseptics. Save on the surface of the skin, the drugs and chemicals which destroy bacteria without producing undesirable effects upon the tissues are few, and not easily applied.

SUPPORTIVE TREATMENT

In the usual course of medical practice, the treatment of disease chiefly consists of supportive measures, as only the exceptional cases are to be benefited by any form of active intervention. Here again those who expect the mysterious will be disappointed. Special stimulant measures and unfamiliar drugs are of some use, but first place is accorded to ordinary care and nursing, supplemented by such measures as the doctor prescribes to diminish exhaustion and to avert special dangers. The processes of nature may usually be relied upon to do the rest. In most diseases these eventually effect a cure. Unless the disease is a fatal one, recovery or death depends upon whether endurance can be fostered until the natural outcome is effected. Many factors contribute to such support.

Rest in bed, in the most appropriate posture, and judicious feeding, may seem to be too simple to deserve attention. Yet when disease is seen in those who have no beds, nor anyone to bring them food and water, their fundamental importance in treatment cannot be questioned. Moreover, in providing these most advantageously for the patient, there is much opportunity for judicious direction and skillful execution. Such care is not to be regarded only as a comfort or luxury; in cases in which the outcome is uncertain it is unquestionably an extremely important factor in eventual recovery.

Next in importance are those measures which tend to diminish discomforts and circumvent or retard special symptoms. Loss of sleep, frequent cough, pain, and all such sources of distress, deserve attention in critical cases, not so much because of their momentary unpleasantness as because their continuance must inevitably produce increasing exhaustion.

Finally, there are the measures classified as stimulation. In certain diseases, notably in heart disease, there is a group of highly effectual stimulant drugs which are of great value. But in all of the less serious illnesses which are not fatal, stimulants in the sense of the more potent drugs are unnecessary; and of critically ill patients who narrowly escape death it is the author's opinion that more owe their recovery to careful general management than to stimulant drugs. Nevertheless, the use of stimulants[4] in dangerous conditions cannot be neglected, and sometimes they are dramatically effective.

Reference has thus far been made to the more rapidly effective stimulants. There are, however, other methods of treatment in which stimulation of the body or of some special structure is employed. Fresh air and sunlight, certain baths, massage, graduated exercise, and electricity comprise one division. Local applications by external heat or by chemical action to increase the circulation of some part of the body form another group. There are likewise measures which stimulate function of particular organs. Heart stimulants have been mentioned. Other drugs stimulate the kidneys, the stomach, or the intestine, such as cathartics or laxatives.

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[4] The term "stimulants" as used here should not be understood to include alcohol, which is not properly a stimulant and is contraindicated in disease unless specially indicated and prescribed.

Supportive treatment may be defined as the modification of the natural bodily processes by all available influences so as to place the patient in the most advantageous condition to resist the disease. A large part of all medical knowledge and experience is concerned with the judicious application of such treatment.

PRECAUTIONARY TREATMENT

In many diseases an important phase of treatment is directed toward circumventing complications. For there are many conditions which in themselves are of less importance than are the complications that tend to follow them, and appropriate treatment has some value in diminishing the danger of such unfortunate results. For instance, the treatment of typhoid fever includes measures to prevent the bleeding or perforation of ulcers in the intestine; the treatment of scarlet fever includes measures to diminish the possibilities of kidney disease or of injury to the heart; the treatment of pneumonia demands watchfulness for empyema which requires surgical interference. An otherwise trivial disease, like measles or influenza, may develop into a serious condition as a result of complications.

DRUG TREATMENTS FOR SPECIAL PURPOSES

From the dawn of history to the present day, the practice of medicine has always been closely associated with the use of drugs, and among persons who are ill the hope for relief through some prescription is almost universal. This faith in the potency of drugs is based upon the important specific service of some, notably the power of opium and its derivatives to soothe pain and induce sleep. But such direct effects of certain drugs have made it easy to fancy virtues in other medicinal substances which really have no effect. Most of the old-fashioned remedies and patent medicines sold today have no value save to satisfy the desire "to take something." Usually, they are taken with the vague hope that they may directly combat some disease, but, as mentioned, there are relatively few diseases for which drugs are direct antidotes.

The real object of drug administration is to cause certain effects upon the body processes when the particular conditions render such influences desirable. Modern investigation has subjected all drugs to searching examination. As a result many have been discarded, and the effects of those that have been retained are known in all their minutiæ. Thus in modern medicine drugs are utilized for definite and particular purposes.

In view of the facts that the desire to take medicines is so widespread, and that there is strong temptation to experiment with a drug when its effects are known, individual drugs will not be mentioned. Most of the drugs of modern medicine have potent actions and are therefore like a two-edged sword in inexperienced hands.

There are innumerable substances which may be used to produce effects upon the body, but those most frequently utilized may be classified in a number of groups.

Anœsthetics.—These are used to produce temporary unconsciousness during which there is insensibility to pain. They are well known and, in fact, are so familiar that it is difficult to form an adequate conception of what surgery must have been before they were discovered.

Narcotics.—These are chiefly derivatives from opium, capable of inducing sleep in the presence of pain. A grave objection to their use is their habit-forming tendency which readily develops into an uncontrollable craving unless great care is exercised.

Hypnotics and Sedatives.—These are drugs of which individual doses diminish nervous restlessness and, if large enough, produce sleep, unless this is prevented by pain. They are, therefore, less potent than the narcotics. Habit formation is less likely with these drugs, although the danger of it cannot be disregarded.

Analgesics and Antipyretics.—Numerous drugs exist which are useful in controlling headache and which have a certain power to diminish pain, especially neuralgic pain, without inducing sleep to any marked extent. They are also able to reduce fever, but are unfavorable to endurance in dangerous fevers such as pneumonia and typhoid fever. These drugs occupy a somewhat peculiar position which deserves comment. In medical practice they are given for definite discomforts not severe enough to require the use of narcotics; in any serious illness they are avoided; on the whole they are considered as minor aids. The public, however, buys them in enormous quantities.[5] In fact, they are the chief resort at present of individuals who desire to dose themselves for varied ill feelings; and although they only occasionally produce ill effects, their indiscriminate use is nevertheless inadvisable. In a few susceptible individuals even small doses may cause fainting or collapse. In large doses some of them cause changes in the blood, producing a peculiar blue-gray discoloration of the face and lips with various symptoms of illness. When taken frequently they may become distinctly habit forming. Moreover, frequent experimenting with any medicine tends to confirm an unwholesome state of fancied invalidism. Drugs should be used only for definite purposes and preferably only upon medical advice.

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[5] See *Nostrums and Quackery*, published by the American Medical Association.

Drugs with Special Actions on the Nervous System.—Through the study of poisonous plants numerous active principles have been discovered, minute amounts of which produce effects upon the body processes without risk of fatal poisoning. Under certain circumstances, such drugs are desirable. For the most part they act through their influences upon the nervous system, being effective in hastening or slowing the heartbeat, in modifying the circulation and blood-pressure, in increasing or diminishing the breathing, in inducing vomiting or sweating, or in increasing temporarily the capacity for muscular or mental effort. The vegetable kingdom has been searched exhaustively for such substances.

Drugs Which Have Special Action upon Certain Organs.—Certain of the vegetable poisons act directly upon organs, independently of the nervous system, notably some which increase the force of the heart's contractions and others which directly increase the production of urine. Still others have the effect of relaxing spasms of involuntary muscles. Many individual drugs have several entirely independent actions upon various body processes, so that in administering a drug for one purpose it is always necessary to consider whether its other effects can be exerted without producing undesirable results.

Animal Gland Products.—In disorders in which there is deficient formation of a certain internal secretion, it is sometimes possible to supplement this deficiency to an extent by administration of a similar secretion obtained from animals. In some instances these animal substances can be given by mouth and absorbed from the alimentary tract, as is the case with thyroid gland products. In other instances the material is rendered inactive by the processes of digestion, so that effects are obtained only when the product is injected through the skin. Aside from their use to supplement a known deficiency, certain internal secretions may be given to secure temporary effects which have been found through medical experience to be exerted by them in a harmless manner, although it is not clear just why they are beneficial. The use of adrenal gland extract in *asthma*[6] is an illustration of this.

Drugs Producing Useful Effects Proved by Experience, but Exerted through Unknown Mechanisms.—There are certain drugs of well-established usefulness which are of benefit in certain diseases, although the manner in which their beneficial effects are exerted is still unexplained. The value of quinine to counteract malaria was recognized long before the malarial parasite and quinine's action upon it were known. The use of mercury and of potassium iodide in syphilis, and of compounds of salicylic acid in rheumatic fever are illustrations of treatment with drugs whose benefits have been demonstrated by the combined experience of the medical profession rather than by any proved theory as to their value.

Local Stimulants and Irritants.—Many preparations are used to produce local effects, either upon the skin or upon mucous membranes. These may be divided into two groups: (1) those used to produce increased blood supply or redness, or increased secretion, which are known as stimulants or irritants according to the intensity of their action; (2) those producing reverse effects, known as protectives, sedatives, or astringents. The first group may be applied to the skin to favor healing of certain lesions. They may be ingested (like the so-called bitters and alcoholic beverages) to improve appetite and to increase the secretion of gastric juice by stimulant action, or (like mustard and the locally acting emetics) to cause vomiting by local irritant action. Most of the cathartics are local stimulants or irritants according to the degree of their action. The second group includes the various ointments and washes used to protect the skin and to control itching or burning. Mucous membranes, being moist surfaces, are less adapted to the use of ointments, but may be influenced by sedative solutions. An astringent is a substance which tends to lessen the secretion of mucus and to diminish excessive blood supply in the mucous membrane, or to counteract stimulation or irritation. These have certain uses in the nose and throat. In the intestinal tract they are of value in diarrhea.

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[6] See section on Asthma in chapter entitled Diseases of the Lungs and Respiratory Tract, p. 294.

Antacids. In the most frequent form of *dyspepsia,* excessive amounts of acid secretion accumulate in the stomach and various alkalies are employed to neutralize this acid. Most of the advertised dyspepsia remedies are composed of sodium bicarbonate (baking soda) plus an irritant flavoring. There is disadvantage in using these too frequently, since the irritant flavorings increase the tendency to dyspepsia in some instances.

Cathartics and Laxatives. Substances that produce evacuation of the intestine are numerous and form perhaps the most conspicuous class of drugs that produce a definite and predictable effect. In past centuries they figured so prominently in the treatment of disease that the word physic was synonymous with medicine, and they were given as a matter of course in practically every illness. At the present time they are used with more discrimination and for particular reasons, rather than routinely. Most of them may be classified under either of two groups: (1) solutions of mineral salts, whose action is chiefly that of a washing-out process; and (2) vegetable or chemical substances that stimulate peristalsis through a certain degree of irritant action. Frequent use of laxatives renders the intestine more tolerant of them and is unfavorable to normal spontaneous action.

Urinary Antiseptics. Most drugs are excreted in the urine, either unchanged, or in converted form. Certain drugs passing from the blood give the urine an antiseptic quality, so that bacteria grow less readily in it. These are used in infections of the urinary tract.

Antiseptics. As mentioned, the use of antiseptics is chiefly confined to the surface of the skin, for the purpose of destroying bacteria in the neighborhood of wounds and also to cure parasitic diseases of the skin. Antiseptics have other more important uses in disinfecting discharges and objects which have been in contact with sources of contagion.

Pharmacology, or that department of medical science which deals with drugs, is constantly testing and investigating drugs, both old and new, and judging by the past decade it is still a fertile field for research. However, it is unfortunately true that the course of medical progress in the treatment of disease has always been marked by greater expectations than have subsequently been realized. This has one far-reaching regrettable result. Newspapers are prone to give sensational reports of unproved advances, and the laity, therefore, is constantly led to expect benefits which cannot be fulfilled. Some of these reports originate in deliberate quackery, through which unscrupulous persons endeavor to exploit the pretended discovery for pecuniary gain. There are many other instances, however, in which the responsibility lies with reporters who have distorted and exaggerated the honest opinions of earnest investigators. Reports of new "cures" should always be submitted to the family doctor, whose opinion of them may safely be accepted, since he usually has knowledge of their sources and other evidence from which he is able to judge their value.

CHAPTER XX

PUBLIC HEALTH AND ORGANIZED PREVENTIVE MEDICINE

In medicine the old adage about an ounce of prevention is literally true, and this has been recognized in all progressive communities by the establishment of health departments under the local governments. The functions of these health departments are numerous and, unlike the advice of the family physician, their measures for the public benefit are backed by authority to enforce them.

The first of these is probably that which concerns the isolation of persons with communicable diseases, and the quarantine of others who have been exposed to such diseases. It is one duty of health departments to see that such measures are effectually carried out. This they do chiefly by approving and supporting the directions of the family physician.

A more highly specialized phase of the method of health departments in dealing with communicable diseases is the tracing of cases, and groups of cases, to their sources by means which the individual physician is scarcely in a position to apply. To this end, it is required that every case of communicable disease shall be promptly reported to the health department. The primary purpose of this is not, as is sometimes supposed, to enable the health authorities to send an inspector who will impose more rigid restrictions than the doctor has already ordered. Ordinarily, the family doctor will be known to the local officials and will have their confidence to such an extent that the isolation and quarantine will be left entirely to his direction. The unwillingness of many patients to have their cases reported is unreasonable, since they need rarely fear any increased restrictions, and should these become necessary, they are only those required by law to prevent further transmission of the disease. Communicable diseases are primarily reported in order that those who are responsible for the health of the community may survey and analyze the situation among the population as a whole. The health officer has but one patient, namely, the whole community. He is called upon to watch the health of this patient daily, so as to recognize promptly all newer occurrences and variations from normal conditions. He must have assurance that all patients who might communicate diseases to others are observing proper precautions. More than this, when any new case of a communicable disease occurs he must do his utmost to determine its source, in order that this source may be properly isolated.

An important aid in detecting the origin of diseases which occur epidemically is to inquire what the various patients used in common at the time when the contagion was contracted. Thus, if all of the persons affected are found to have used drinking water from a certain well or water system, that water will be under suspicion and must be investigated; if all received milk from the same route, the milk is under suspicion; if all cases have come from the same school, or have eaten in the same restaurant, or slept in the same dormitory or barracks, search must be made for a carrier. To apply this very important method it is highly necessary that every known case be reported.

The final proof of many of these sources requires bacteriological or other laboratory work. Therefore, health departments maintain suitably equipped laboratories, which also make diagnostic tests of the more complicated kind for the benefit of physicians.

Another duty of the health department is to carry out requirements of such laws as may exist regarding vaccination and other matters. It also supplies diphtheria antitoxin and other substances for many non-compulsory immunizing processes.

The public health administration has further duties which come under the head of sanitation. These include protecting the water supply; sanitary disposal of sewage, garbage, and manure; inspection of milk, food, and habitations; fly and mosquito control.

A more recent development among public health measures is child sanitation, which includes inspection of schools and measures to reduce infant mortality.

It is a further concern of the active health department to educate the public in health matters, both in the general principles which must be understood for the support of public regulations and also in personal hygiene. Mental hygiene is a subject recently added to the field in which educational guidance may be applied.

The compiling of vital statistics is also a duty of the health department.

PART II

DISEASES

INTRODUCTION

What has been written thus far represents a summary of the first two academic years of a course of medicine, covering the subjects commonly known as the preliminary sciences. Some comment on conditions which obtain in medical practice have also been included, but the more detailed and individual aspects of the various diseases have yet to be described.

In the chapters on pathology the fundamental nature and causes of disease have been discussed, as well as the resultant changes in organs and alterations of their vital processes. Something has been mentioned as to how the harmful effects of disease are produced. But from the descriptions so far given the reader can scarcely form an adequate idea as to how the abnormal internal conditions occurring in any particular disease disturb the feelings and affect the actions of the patient.

In the following pages, an attempt is made to convey general information as to what is meant, both from the human and from the scientific standpoints, by some of the more important diseases. Obviously, the account of each disease must be brief, and the great number of rare disorders must, of necessity, be entirely excluded, since to accomplish more would require many volumes. Even this cursory account will probably contain more facts than most readers will be able to retain permanently. Nevertheless, all of the subject matter presented is selected from the much greater total of medical knowledge as information which, in the author's opinion, should be clearly conveyed to the laity.

An effort has been made to avoid statements which may cause confusion, or be susceptible of misinterpretation. But it is rather difficult for a layman to adopt the point of view readily gained through medical experience, especially in regard to two particulars:

1. Although some descriptions of anatomy, pathology, and bacteriology have been given, it is possible that the reader will have difficulty in following the many references to bacteria and to the changes in organs, such as inflammations and tumors. Every medical student has handled and examined specimens of lungs solidified by pneumonia, of tumors which have grown on various organs, and of hearts with diseased valves; he has also studied such tissues microscopically. And, in diseases due to bacteria, he has seen the bacteria. A physician views disease in his patients in the light of such knowledge. The layman, on the other hand, can know these abnormalities only by hearsay, or more vaguely. The reader, however, may be assured that all of the organic abnormalities to be described are such as he himself could see and feel, if he had opportunity. There is no uncertainty about them, even though most readers without access to medical museums will be able to visualize them only from description.

2. Even the diseases most frequently seen by physicians are comparatively rare in the personal experience of most laymen. A hospital doctor frequently has under his care simultaneously six or eight cases of pneumonia, whereas a layman may not hear of a case of pneumonia among his personal acquaintances as often as once a year. Thus, diseases which are daily events in the life of the doctor are, as a rule, unfamiliar and somewhat awe-inspiring to the layman. It may be well for the reader to realize at the outset that the likelihood of personal experience with any particular disease of which he reads is remote.

All of the conditions requiring diagnosis and treatment in the practice of medicine may be roughly divided into three groups: (1) medical diseases, not involving surgical procedures; (2) surgical conditions, in which operative methods and mechanical appliances play a part; and (3) those diseases and disorders of special organs of which there is more to be known than can ever be learned except by specialists who have devoted themselves to these subjects to the exclusion of all others. The description of these diseases involves the presentation of many facts, for the most part bearing little relation to each other. Any orderly arrangement is difficult, but the sequence followed is that which is usual in medical teaching. Medical diseases divide themselves into certain groups, as indicated by the titles of the subsequent chapters. The diseases discussed may be located by means of these chapter headings and the index.

CHAPTER XXI

INFECTIONS

TYPHOID FEVER

IN most textbooks and courses of lectures on diseases, typhoid fever usually receives first place. No doubt this originates in the fact that formerly typhoid fever was one of the commonest serious diseases. Up to twenty years ago, each September and October found the wards of hospitals filled with cases of typhoid fever, almost to the exclusion of other disorders. Now it is a comparatively infrequent occurrence, and the cases are usually scattered. There are, however, advantages in discussing this disease first, since, apart from its statistical importance, it is representative of fevers in general. Considerable is known about its cause and nature, but much remains unknown or is undeterminable in individual instances. Directly curative measures are still lacking, but such medical treatment as is employed does much to diminish the danger of death and shorten the period of disability. By way of prevention, much has been accomplished. For these reasons typhoid fever will be discussed somewhat more fully than other infections.

Typhoid fever, also called *enteric fever,* is an infection by the typhoid bacillus, which has been ingested usually about two weeks prior to appearance of the first symptoms. While its source is some one who has the disease, or some other carrier, it is usually indirectly transmitted by food and drink.[1] Polluted drinking water, milk and ice cream, oysters from polluted sea water, and fly-contaminated or carrier-contaminated foods are responsible for almost all of the traceable cases.

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[1] The typhoid bacillus is one of the very few bacilli that thrives in water and milk.

In its earlier stage the disease is a general infection of the entire body with the bacilli, which exist in the circulating blood. But there is also one important local change in the tissues, namely, the formation of ulcers in the lower part of the small intestine. The fever and other general symptoms are attributable to the invasion of the body by the bacilli. The ulcers of the intestine produce a certain degree of disturbance of intestinal functions. They are also the source of the two most important complications—hemorrhage, or bleeding from an ulcer which has eaten into a blood-vessel; and perforation, or breaking through of the base of an ulcer, causing peritonitis.

The mortality from typhoid fever is about eight per cent, higher in older persons and much lower in children.

The symptoms develop somewhat more gradually than do those of most other fevers, beginning with a little feverishness and perhaps headache, which are at first not apt to be taken seriously, but which increase from day to day. In contrast with pneumonia, for which a physician is ordinarily called at once, it is usually three or four days after the onset of typhoid fever before a doctor is consulted. Restless sleep and disturbed dreams are frequent early symptoms which are the forerunners of the delirium and stupor characteristic of all but the exceptionally mild cases.[2] The typical course of the disease is continuous high fever for two weeks or so, with a gradual swing toward normal in the following week or two. Throughout the period of high fever, the patient is likely to be in a state of almost complete stupor combined with restlessness or delirium. After recovery, there is often no memory of this period. Rapid loss of flesh is the rule except in the few cases in which nutrition can be maintained with unusual success.

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[2] The word "typhoid" means resembling typhus. Typhus fever is derived from the Greek word meaning stupor.

The stage of fever, stupor, emaciation, and increasing weakness is naturally a cause of great alarm to relatives. However, comfort is to be derived from the fact that, even in the severe cases, the disease seldom fails to subside before exhaustion proves fatal, provided complications do not occur.

In the early stages constipation is usually present, but there may be diarrhea. Throughout the course of the disease there is a distinct tendency for the abdomen to become distended by the accumulation of gas in the intestine. As this increases the danger of bleeding or perforation of the ulcers, one of the objects of treatment is to prevent excessive distention.

Hemorrhage, while the commonest complication, is much less serious than perforation. In perforation, with consequent peritonitis, prompt surgery is necessary to save life.

In the treatment of typhoid fever, as in that of most diseases, it must not be expected that the administration of any drug will exercise a commanding effect upon its course. Certain medicines are useful in relieving particular symptoms and in affording support, but they must not be regarded as the chief factors in treatment. If, as will often be the case, no medicine is prescribed for continuous administration, it should breed confidence in the physician rather than doubt as to his ability. There are various drugs which might suggest themselves to those with a partial knowledge of medicine, that are distinctly dangerous in typhoid fever. After the first week of the disease cathartics should be avoided.

Careful dieting and protective nursing are the first essentials. In directing the diet, the objects are two: (1) It is necessary to prevent or combat flatulence and diarrhea; (2) so far as is possible, without causing these symptoms of intestinal indigestion, it is desirable to provide nourishment sufficient to minimize the emaciation. Thus, while underfeeding is safer than overfeeding, a well-planned, medium course is better than either, both to promote endurance during the disease and to shorten the convalescence. The diets in typhoid fever are usually based upon standard lists which have been approved by usage in large numbers of cases in hospitals.

Nursing should include complete rest in a properly constituted bed. In delirium, close watch must be maintained to prevent dangerous acts like jumping from a window. Precautions should be taken to avoid bedsores, or gangrene of the skin where bones press against a hard bed. Care of the mouth is important, to prevent drying and cracking, which in untreated cases may interfere with nourishment. Moreover, measures are necessary to prevent communication of the disease—the urine as well as the intestinal discharges being a ready vehicle for the bacilli.

Cool baths with friction are of definite value in typhoid fever. Their object is not so much to reduce fever, although extremely high fever is best reduced by baths, as to serve as a tonic to the circulation and to improve the mental condition.

The bowels should be made to move as necessary by enemas, not by cathartics. Water is to be taken freely to promote the flow of urine.

There are many other details that should be given appropriate attention according to the requirements of the particular case. Of these, perhaps the most important are sleep, and the quieting of restlessness, but there are many ways in which judicious management is of great advantage, both during the active course of the disease and in convalescence.

In preventive medicine, typhoid fever is an important subject with many subdivisions. It is this disease, more than any other, that has led to the establishment of protected water supplies and of sewer systems. It is undoubtedly these measures of municipal sanitation which have practically resulted in rendering typhoid fever a disease of rural districts rather than of cities. The tracing to their sources of such outbreaks as still occur is an important function of health departments.[3]

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[3] For methods, see chapter entitled Public Health and Organized Preventive Medicine, p. 203.

The discovery and control of carriers serving as food handlers is one phase in the prevention of typhoid fever which still presents practical difficulties, and in which understanding and intelligent coöperation by the public is greatly needed.

By way of personal protection against the disease, in times when the source of an epidemic has not been determined, much may be done to diminish the danger. If drinking water and milk are boiled, if ice cream, raw oysters, and other uncooked foods are avoided, and if cooked foods are guarded from handling and from flies after cooking, most of the usual sources of infection will be eliminated. Attendants who care for patients with typhoid fever should wash their hands thoroughly after each contact and before meals. Preventive inoculations have much to recommend them, especially before travel in regions where typhoid fever is prevalent, as well as during epidemics at home. Immunity lasts about two years.

PNEUMONIA

At the present time pneumonia is the most prevalent of the serious acute infections, and has the greatest mortality. Not only does it appear as a disease entity, but it often occurs as a complication in other disorders.

Pneumonia may be defined as a condition in which, through a peculiar inflammation, lung tissue becomes solidified, the air spaces being filled with solid clot-like material.[4] Many different bacteria occasionally cause pneumonia, but, apart from these few exceptional cases, it is an infection of the lungs by pneumococci.

The manner in which the infection is conveyed is less clear than it is in typhoid fever. While in a few instances pneumonia seems to be contracted from another person similarly affected, other cases cannot be traced to this source. There is also reason to believe that a temporary lowering of the natural immunity, or a susceptibility to infection, plays a certain part in the development of symptoms. In many cases a common cold which ordinarily would have passed without causing difficulty precedes the onset. Such colds are often due to pneumococci but usually do not result in pneumonia. Some evidence exists to establish the fact that a common cold may eventually develop into pneumonia when the general physical condition is impoverished by reason of exhaustion, or other causes.

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[4] See section on Pneumonia in chapter entitled Pathology, or Tissue Changes in Injury or Disease, p. 134.

Cases vary as to the extent of consolidation but the seriousness of the condition is not always proportionate to the amount of involvement. The symptoms and harmful effects of the infection do not seem to be due so much to loss of function in the lung tissue as to the general poisoning incidental to infection.

The onset of pneumonia is usually sudden, with a high fever and frequently a severe chill. If the pleural surface of the lung is attacked, as well as the lung tissue beneath the surface, there is pain in one side of the chest, which is aggravated by breathing or coughing. Some cough is usually present, and if sputum is raised, its consistency is sticky and it has a pinkish or yellowish-brown "rusty" color. Following the onset, the course is usually one of acute illness for about ten days, and if death has not supervened, there is then a rather rapid cessation of symptoms. This is called the crisis. The acute period seems to represent the stage in which the infection is constantly producing poison; the crisis presumably represents the development of the natural antibodies that finally overcome the bacteria.

The chief symptoms are those of the poisoning process, namely, fever with general discomfort, restlessness and a tendency to delirium, rapid pulse, and an increasingly rapid rate of breathing, which seems to be due to the poisoning rather than to the changes in the lungs. In serious cases, the patient may be only partially conscious. A cough, which may be frequent, exhausting, and may often interfere with sleep is symptomatic of the inflammatory process in the lungs. Often there is great difficulty in raising sputum, but the usual course is painless, except for a short period at the onset.

Nourishment is taken unwillingly, if at all, the patient becoming gradually weaker. Finally, there is either collapse, or the favorable crisis leading to convalescence and recovery. Pneumonia may be readily contrasted with typhoid fever. In the former, the outcome is largely a matter of endurance, most fatalities being directly due to exhaustion. In the latter, the exhaustion in itself is often alarming, but, in the absence of complications, has small fatal significance.

The most frequent complication of pneumonia is empyema, or the formation of pus in the pleural cavity, requiring surgical drainage before convalescence can progress. Usually, this complication is one which becomes evident after the pneumonia has abated.

The mortality from pneumonia may be roughly approximated at twenty-five per cent. This figure is higher by reason of the inclusion of cases in old people or in those weakened by other diseases; in children and in young adults the outlook is brighter.

By way of treatment, a specific cure to hasten the crisis has not yet been realized. In the past ten years a serum has been developed which may be of some advantage, but this is relatively slight and has been disputed. Moreover, the method involves certain difficulties and discomforts. In the forms so far available, it has not been generally advocated, but it is still in the experimental stage and newer forms are constantly being tried.

Of greater effect in favoring survival than any present specific treatment is careful general management to lessen the wearing effects of the stressful period. Comfortable support in bed, fresh air, diet and drink according to the patient's ability to receive nourishment, sleep, and the reduction of cough are the important aspects of treatment. Attention to these may be expected to prolong endurance and so to increase the prospect of recovery.

As in typhoid fever, drugs are used for special purposes rather than for any curative effects. In the most alarming stages the so-called stimulants play a certain rôle. Alcohol, however, which was formerly given in most cases of pneumonia, is now not generally recommended, as it is believed that its ultimate effect does not favor prolonged endurance.

Pneumonia may be regarded as a contest between the forces of immunity and those of disease. Since, as yet, immunity cannot be hastened or the disease inactivated, the object in treatment is to support the patient until this contest can be won by the natural forces.

Preventive medicine has not yet made conspicuous progress in the control of pneumonia. Undoubtedly the isolation of patients is to be recommended, but there are no general preventive measures which have proved effectual. The avoidance of fatigue and exposure during and after ordinary colds represents the part of prudence. The administration of preventive vaccines to bodies of troops during the late war resulted in a certain reduction in the statistics of pneumonia, but hardly so great a one as to establish their practical usefulness.

INFLUENZA

In the fall of 1918 the world was swept by an epidemic of *influenza* which resulted in many deaths. About twenty-five years previously another general epidemic of influenza occurred with only a small rate of mortality. The difference seems to have been due to the fact that one of the characteristics of the epidemic of 1918 was a predisposition to pneumonia as a complication, a tendency which the earlier epidemic did not have. Before and since 1918 there have been scattered cases, and also minor epidemics, of a disease (or diseases) which may or may not have been similar to the influenza of 1918, minus its complication of pneumonia. Formerly, these cases were called influenza. More recently, care has been taken not to use this term because of its alarming suggestions, but no other appropriate name has yet been suggested. Influenza, as understood by a physician, denotes a fever of sudden and often violent onset, but of short and favorable course, subsiding within a few days and ordinarily without complications.

A small bacillus has been regarded as its cause, but this fact is not firmly established. The complicating pneumonia of the cases in 1918 was due to the ordinary pneumococci.

While, in most cases of influenza, there is a certain amount of inflammation of the upper air passages, there are no changes in the organs or tissues of the body at all proportionate to the general symptoms.

Treatment consists chiefly of measures to relieve the discomforts, combined with rest in bed and general care which undoubtedly tend to lessen the possibility of serious complications.

No effectual prevention is known, but it is generally assumed that the avoidance of crowds and close contacts is advisable during epidemics.

SEPTICÆMIA AND PYÆMIA

Septicœmia[5] may be defined as a condition in which bacteria are present and grow in the circulating blood, causing general symptoms of infection without necessarily producing local inflammation in any one part of the body.

Pyœmia,[5] on the other hand, is a condition in which an inflammation in one part of the body is followed by successive local inflammations in other parts. The infection is apparently carried from place to place by the blood, but the bacteria seem to invade the blood only in transit, and are not constantly demonstrable in the blood as in septicæmia. The symptoms are those of local inflammation and abscesses.

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[5] The vague term "blood-poisoning" may refer to either of these conditions. More often, however, it seems to be commonly applied to local infections, as of the hand or foot, which are severe enough to cause fever, but in which there is no infection of the blood.

The termination *æmia*, found in so many medical words, is derived from the Greek word *aima*, the blood. Thus septicæmia means a septic condition of the blood, or a state in which the blood is infected with bacteria. Pyæmia, (*pyon*, pus), in like manner, means by derivation a condition in which pus has entered the circulating blood.

Both septicæmia and pyæmia are comparatively rare conditions, but are mentioned here because of their seriousness when they do occur. Both are usually the result of some preceding local infection, as, for instance, that sometimes occurring after childbirth.

Various bacteria may infect the blood, but streptococci and staphylococci figure most frequently. The seriousness of the condition varies greatly according to the type of bacteria and the susceptibility of the patient, there being even greater difference in individual cases caused by the same bacteria. While the worst instances are rapidly fatal, some exceptional cases are mild, terminating in recovery.

The treatment in each case differs according to the type of bacteria. There are sera that check the activity of certain bacteria, particularly those that cause meningitis and anthrax. Naturally, they are of great value. Other organisms such as streptococci and pneumococci resist serum treatment. Certain chemical treatments are at present under investigation, but it is too early to say anything definite of their value.

On the whole, however, the treatment is largely supportive. Abscesses of pyæmia require surgical interference.

MENINGITIS

The meninges are membranes which envelop the brain and spinal cord and, when their infection occurs, the inflammation known as meningitis spreads over the surface of the brain and down the spinal cord. There are different varieties of meningitis. One form follows infection of the middle ear; another is a manifestation of pyæmia; another is a complication of pneumonia; there is also a tuberculous form. All of these are usually fatal. But the type known as *epidemic meningitis,* due to the meningococcus,[6] is curable to a considerable degree.

Epidemic meningitis is a relatively rare disease, but sometimes it becomes epidemic or more prevalent, especially under conditions of crowding. There was a notable increase in certain army camps during the late war.

It is an infection of the meninges by a double, kidney-shaped micrococcus which results in widespread inflammation about the brain and spinal cord. The organism is found in the throats of certain healthy people who perhaps serve as carriers, but it is seldom if ever possible to trace a given case of epidemic meningitis to any individual carrier as its source. The transmission of the disease from a patient to others seldom occurs, although precautions against such transmission should always be taken.

It is probable that, as in typhoid fever, there is a preliminary stage in which the bacteria are present in the blood as a septicæmia. In rare instances meningococcus infection can be recognized in this stage and cured before the development of actual meningitis. When the meninges are attacked, the normally clear fluid surrounding the brain becomes turbid, like thin pus, and contains the bacteria.

The symptoms are usually of sudden onset and may be either very severe or relatively mild. They consist of fever, headache, and, in severe cases, increasing delirium which develops into unconsciousness. The most pronounced characteristic of patients with meningitis is a backward bending of the neck, with rigid resistance to all attempts to bend the head forward. The presence of this feature does not necessarily indicate meningitis, however, since it is often a concomitant of other fevers, such as pneumonia and tonsillitis. The only way of absolutely determining the presence of meningitis is to draw some fluid from about the spinal cord for microscopic examination. This procedure is called *lumbar puncture,* and may be readily performed through a hollow needle without danger and with very little pain. It is highly necessary, since, if meningitis is present, a great deal depends upon its early recognition and prompt treatment.

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[6] See section on Important Bacteria of Disease in chapter entitled Infections by Bacteria, p. 175.

Epidemic meningitis is treated with a serum administered by means of lumbar puncture.

The course of the disease is very variable but ordinarily rapid. In the most severe cases, death supervenes within the first twenty-four hours despite the most energetic treatment. In certain milder cases, the course is not satisfactorily affected by the usual treatment, the fever and stupor continuing for two or more weeks; in such cases recovery may eventually occur. In most cases which are treated promptly with serum, the result is rapid improvement, all active symptoms subsiding within two or three days after treatment has been instituted. Comparative statistics would indicate that serum treatment has reduced the mortality from a range of from fifty to eighty per cent, in untreated cases, to about twenty per cent in those treated.

Preventive measures in armies have included isolation of all persons whose throats contained meningococci. The practical results, however, were inconclusive.

Individual patients should be treated as if they were active carriers, although the danger of contagion from them is slight.

DIPHTHERIA

Much has been accomplished in the prevention and treatment of diphtheria. Nevertheless, the disease occurs, some of the cases proving fatal, since scientific progress in this field has not yet become proportionately reflected in medical practice. Diphtheria is far less prevalent and probably milder now than formerly but, unless it receives prompt treatment, it is still an exceedingly dangerous condition.

Diphtheria is a local infection of the throat by the diphtheria bacillus. The source in many cases cannot be traced, unrecognized carriers probably being responsible, but the known cases constitute a danger to those about them both during the attack and for a certain time thereafter. The bacilli grow only in the throat (rarely on other mucous membranes or in wounds), setting up an inflammation which results in the formation, on the surface, of a grayish-white patch of inflammatory material, called a false membrane. This membrane is usually (but not always) visible upon examination. There is a certain amount of sore throat, but the serious and often fatal results of the disease are due to a poisonous product of the bacteria which is absorbed by the circulation from the local infection and carried throughout the body. This poison produces fever and poor circulation with a serious state of weakness which, unless controlled by antitoxin, may prove fatal.

A particular danger in diphtheria is that the membrane may extend into the larynx causing obstruction to breathing, a condition in which it is sometimes necessary for a surgeon to insert a metal tube into the larynx, or to make an opening in the windpipe to avert suffocation.

In a certain proportion of cases, two unfortunate results may occur after the subsidence of active symptoms—namely: (1) a paralysis of the throat or of other parts of the body, which may last for some months, and (2) heart weakness. These are due to poisoning by the diphtheria toxin, and are less likely to occur if antitoxin is promptly administered.

Effectual treatment in diphtheria is hampered more by delay in obtaining medical attention than by lack of an efficient remedy, for antitoxin given within the first two days of the disease is almost unfailingly curative, whereas if its administration is delayed, it is far less effectual. In diphtheria, therefore, those not inclined to seek prompt medical counsel may have particular cause to regret their negligence. In any illness involving sore throat, it is the part of prudence to consult a physician. Diphtheria should be suspected if the patient seems sicker than either the sore throat or the degree of fever would seem to warrant. If a white patch is visible in the throat (other than minute white specks on the tonsils) diphtheria is probably present. If there is difficulty in breathing, and no experienced person is about to differentiate the condition from a common croup, there is urgent need for prompt medical attention.

The taking of cultures is an important method of verifying the diagnosis.[7] In the occasional cases where the membrane is in a part of the throat hidden from view, cultures give the only conclusive evidence.

Treatment consists in the injection of antitoxin through the skin, in an amount estimated to be somewhat more than sufficient. If this is done in the early stage of the disease, one may expect a marked subsidence of all the general symptoms within a few hours.

If mechanical obstruction of the larynx occurs, it is treated either by the insertion of a special tube through the mouth, or, in emergency, by opening the trachea.

In the management of the patient, isolation is naturally important and is indicated until the bacilli are no longer demonstrable by culture.

As a preventive measure, the immunization of school children with minute amounts of an admixture of toxin and antitoxin is easily performed and should be generally employed.

Immediate immunization of persons who have been exposed to diphtheria may be secured, by promptly administering a small dose of antitoxin.

There is one unfortunate aspect in the treatment of this disease seldom understood or appreciated by the layman. In some cases, even an expert of special experience cannot immediately determine with certainty whether or not diphtheria is present, and the waiting for more positive evidence might result in a delay disastrous to the effectual administration of antitoxin. Under such circumstances, it is a recognized principle among physicians that antitoxin should be given. If the disease is diphtheria, much is gained, and no essential harm is done if it is not. Many doctors have been subjected to unjust criticism for administering antitoxin when diphtheria was not found to be present; they should rather have been praised for having provided a sort of insurance in a situation of necessary uncertainty.

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[7] See chapter entitled Infections by Bacteria, p. 166.

TUBERCULOSIS

Pulmonary tuberculosis, formerly called consumption, is the commonest form of this disease but tuberculosis is by no means only a disease of the lungs. There are certain cases of general tuberculous infection in which practically all parts of the body are involved. There are also localized tuberculous infections of various organs of the body, from the skin to the bones, including even the eye and ear.

The tubercle bacillus, as mentioned elsewhere,[8] is commonly derived from other human disease, or from the milk of tuberculous cows. There is reason to believe that in most instances it is acquired in childhood, and that when the disease first becomes apparent in adult life it represents a lighting up, from unknown causes, of the earlier infection.

Tuberculous changes, in whatever organ they occur, represent a distinctive type of chronic inflammation, which results in cellular destruction combined with the formation of fibrous scar tissue. This inflammation appears first in tubercles of microscopic size, but later marked, visible changes are produced by the coalescence of many growing tubercles. Within such diseased tissue, and in material such as sputum discharged from it, tubercle bacilli are demonstrable by microscopic examination. Whenever the process is sufficiently active and extensive there is fever and wasting. In favorable cases the tuberculous involvement of tissue may cease to extend, gradually being inclosed in scar formation, and so become quiescent, even permanently.

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[8] See section on Important Bacteria of Disease in chapter entitled Infections by Bacteria, p. 177.

Unlike most infections, tuberculosis is characterized by gradual development and by long duration, save in the rare, acute forms.

Whether the lung or some other organ is attacked, the symptoms are due partly to the general absorption of poisonous products, and partly to the local destruction of tissue.

Tuberculosis anywhere in the body is most apt to demonstrate its presence by general symptoms. These begin, as a rule, so insidiously that it is impossible to ascribe a definite date to their onset. They are also vague and variable in different cases, but for the most part come under two heads, fever and malnutrition. In the less pronounced cases, the fever is represented by rises of temperature of not more than a degree or so, usually in the afternoon or evening. There may be a tendency to flushing. Later there may be sweating during the night. When fever is not recognized, a gradual loss of weight is often the first noticeable symptom; or it may be weakness and easy fatigue. All of these symptoms may be present without tuberculosis, but if they occur in the absence of any other clear explanation, tuberculosis is to be considered as a possibility.

Tuberculosis of the lungs is commonly associated with cough, but in its early stages the cough is often slight or even absent. Later, it becomes more pronounced and sputum is raised. Blood in the sputum, or bleeding from the lungs (called *hemoptysis*) not necessarily preceded by cough, results more often from tuberculosis than from any other cause, and should always be reason for seeking medical advice. In actively progressive tuberculosis of the lungs there is fever, increasing weakness and emaciation, combined with cough and sputum. The cough, if violent, may cause vomiting. There are often drenching sweats. In advanced cases, with extensive changes in the lungs, there is frequently shortness of breath. The symptoms, the physical examination, and the X-ray examination all contribute to the diagnostic evidence. In certain cases, any one of these alone may be practically conclusive, but the final proof depends upon the microscopic demonstration of tubercle bacilli in the sputum.

The local symptoms of tuberculosis other than pulmonary will be referred to in discussing the diseases of special organs.

Numerous specific treatments and cures for tuberculosis have been attempted and have received publicity, but none as yet have proved of appreciable value. Some premature reports of success have been published by newspapers based upon the work of earnest investigators who have been the first to protest their publication. Other reports have been purely fraudulent. All have been unfortunate in that they have raised false hopes. Incidentally, so many worthless "cures" of disease are advertised from time to time that the public will do well not to heed reports from irresponsible sources.

The treatment of tuberculosis consists primarily in supporting and increasing the patient's resistance to the disease by natural methods. In all forms the essentials of treatment are rest, fresh air and sunlight, and careful dieting. These should be planned for systematically, and are best obtained in a sanatorium, since at home there are many temptations to permit irregularities. Under careful medical supervision, exposure of the skin to sunlight so as to produce tan (*heliotherapy*) is of late proving of value in certain cases.

The mental condition must not be neglected. Contentment and cheerfulness, and absence of worry, of boredom, and of discontent are important aids to favorable physical progress. The patient with tuberculosis should make a hopeful effort to bring the disease to a standstill. To this end the physician's advice should be implicitly followed and the patient should realize that time devoted entirely to the business of getting well will be economy in the end. Moreover, treatment should not be discontinued before permission is given. Many unfortunate results arise from overconfidence and cessation of treatment upon partial recovery.

Precautions for the safety of other persons should be taken, particularly as to the sputum, coughing toward others, and as to what objects may be touched with contaminated hands. Children particularly should be safeguarded.

Public health measures have been intensively directed against tuberculosis. Since the isolation of the tubercle bacillus there has been a marked decrease in the prevalence of the disease.

CHAPTER XXII

INFECTIONS (*Continued*)

MEASLES

MEASLES and whooping cough are the two diseases which nearly all city dwellers have sooner or later, generally in childhood. Both are often regarded as trivial matters, but in reality deserve more consideration than they are usually accorded.

Though the cause of measles and the method of communication are not known, the disease is highly contagious. Exposure of a child who has not had measles to one who has it will usually result in contraction of the disease. The communicability is much greater than that of scarlet fever or of diphtheria. The incubation period between exposure and appearance of the first symptoms is from seven to eighteen days. One attack usually confers immunity.

The disease is characterized by a coarsely mottled pink rash, most marked on the face and the upper part of the body. This rash, however, does not appear until about the fourth day of the illness. Before it develops there is fever, watery discharge from the eyes and nose, and slight cough. One reason for the continued prevalence of measles is the difficulty in recognizing the condition in its early stage when it is most contagious. Soon after the rash is "out," the fever disappears, and the disease ceases to be contagious five days after the appearance of the rash.

The serious aspects of measles are derived from its complications, chief among which are pneumonia and disease of the ear. In the months following recovery good living conditions are important since there is a certain tendency to ill health long afterward.

Treatment includes prompt isolation as soon as the condition is recognized or suspected. The care of the patient is only protective and supportive. Warm, moist air in the room tends to soothe the cough and may lessen the danger of pneumonia. Patients with measles should not be exposed to persons with colds, and are best treated when separated from other measles patients, to prevent the transmission of complications.

Since the disease is communicable before positive diagnosis is possible, effectual preventive measures are particularly difficult. They consist in excluding all suspected and exposed cases from schools, and in the isolation of known cases.

It is highly desirable that the public should coöperate intelligently with doctors and health departments in carrying out precautions against the spread of measles, and of all similar communicable diseases. It should be recognized that if every reasonable precaution is generally observed it will add to the safety of each individual.

One common but unwise attitude toward measles deserves special comment. There are those who advocate the exposure of children to measles to "have it over." This is highly imprudent, as the disease is relatively more dangerous in young children. It is safer therefore for the attack of measles to be deferred.

As yet, no specific treatment of measles has been established. It has been proved, however, that the blood-serum of convalescent patients will serve as an antitoxin. There is hope, therefore, that an animal serum may be developed.

Protective treatments against measles are under investigation but have not yet been established.

SCARLET FEVER

During the past half century the incidence of scarlet fever has been lowered to such an extent, and the cases have become so much milder, that the disease is no longer as vitally serious as it was. Its mortality is about that of measles. In a measure, this may be attributed to the general improvement in methods of isolation. Moreover, new methods of prevention and treatment have recently been established which give the assurance that there will be no difficulty in coping with the disease in the future.

Scarlet fever is an infection by a streptococcus which has only recently been differentiated. Its chief inflammatory reaction occurs in the throat. The communicability is less than measles, so that it is not always contracted after an exposure. Its incubation period is one to eight days. The subsequent immunity is practically complete.

The attack begins with fever, sore throat and, as a rule, with vomiting. Usually on the second day, a rash appears which is finer, less blotchy, and brighter red than that in measles. The chest is particularly affected. In the absence of serum treatment, the fever continues, gradually subsiding about the seventh day with a cessation of all symptoms. The skin soon begins to peel but the peeling process usually continues for three to six weeks.

As in many other diseases, it is the complications which are largely responsible for the mortality. In scarlet fever these may be various. Ear disease, inflammation of the glands of the neck, pneumonia, and joint infection may appear early. After the attack is apparently over, precautions are still necessary against kidney disease and valvular disease of the heart, either of which may appear during convalescence.

Prompt serum treatment before the development of complications is effectual. There is available a newly developed serum that quickly reduces the fever if administered early in the course of the disease, but like other serum treatments its use involves certain discomforts. It is invariably indicated in severe cases, but in milder ones a physician may well question its necessity. The basis for decision as to its administration is still debatable.

The remainder of the teatment includes measures to support and comfort the patient during the fever. Because of the possibility of heart and kidney complications, instructions as to diet and rest in bed should be followed implicitly.

Isolation must be continued longer than in measles. It is an unfortunate fact that in the few cases with discharging ears, or discharging glands of the neck, the period of possible transmission is greatly prolonged.

In scarlet fever preventive measures are more effectual than in measles, since isolation in the former is possible before the most contagious stage is reached. It is also probably true that the public is more willing to exercise precaution against scarlet fever than against measles.

Occasional local epidemics have been traced to milk supplies. There is now available a protective treatment against scarlet fever which can be used effectively whenever circumstances require.

ERYSIPELAS

Erysipelas is a rather frequent disease, especially in or beyond middle age, and while, in itself, the condition is only moderately serious, it may easily prove fatal when occurring in old people, or in patients weakened by some previous disease.

It is an infection of the skin, usually of the face, by a streptococcus, and is somewhat communicable.

It begins as a spreading inflammation of the skin which becomes markedly red and swollen over an increasing area, but pus formation does not result. The fever, which is always an accompaniment, may be high and may continue for about a week. At the end of that time it falls rather rapidly and the swelling subsides. There is no scarring. Complications are unusual.

Treatment includes various local applications which may afford some comfort, but their influence on the course of the disease is questionable. Generally, the natural forces may be relied upon to effect recovery. Serum treatment has recently been advocated but its use is not as yet fully established.

Isolation is always indicated, particularly in cases occurring in hospitals, and should be maintained until peeling takes place at the site of infection.

CHICKEN-POX

This is a prevalent disease of childhood, but its general importance is lessened by the fact that it is almost without mortality and is seldom followed by complications. Since the incubation period is a long one, up to three weeks, and quarantine is necessary, much loss of time is occasioned.

The cause of the disease is unknown but it is highly contagious.

It begins with feverishness and often headache, which may be quite severe or so slight as to pass unnoticed. The following day small superficial vesicles (blisters) containing clear fluid, surrounded by a little redness, appear in variable numbers on the back, the trunk, the face and limbs. In some cases there are sores in the mouth which may be rather painful. By the second or third day the fever disappears and the child feels well. The blisters dry to scabs and fall off within two weeks. They leave no scars unless scratched.

Aside from a clean nightdress and the prevention of scratching or infection of the pocks, treatment consists only in isolation.

Preventive measures include quarantining of exposed children. There is no method of immunization.

SMALLPOX AND VACCINATION

Smallpox is still a public menace and this fact cannot be overemphasized. Since the discovery of vaccination by Jenner in England in 1798, the disease has been relatively under control, and such outbreaks as have occurred have been checked before becoming widespread, but there is reason to fear that prolonged freedom from its prevalence is at present breeding false confidence. In some quarters negligence has developed in regard to vaccination which may well be preparing the soil for future epidemics.

Smallpox is a disease with high mortality and of extreme communicability. While the immediate cause is not yet known, unvaccinated persons who come into close contact with the disease usually contract it. Thus, in the absence of vaccination, smallpox spreads with great rapidity, producing sudden and formidable epidemics.

Eight to twenty-one days covers the incubation period. The chief tissue changes are the pocks of the skin, usually most numerous on the face. In contrast to the superficial blisters of chicken-pox, these first appear as hard, shotlike nodules beneath the surface. The skin eruption is preceded by fever which drops, and rises subsequently as the contents of the pocks change from a watery fluid to pus. Infection of the pocks by bacteria in the skin undoubtedly bears some relation to this second period of fever.

The symptoms begin suddenly and violently. In addition to high temperature there is, in most cases, severe pain in the back, and usually vomiting. The rash is first seen on the third day, after which there is a short deceptive improvement. Then the fever again increases and for the next week the condition is critical. Delirium, stupor, and increasing exhaustion are the rule. As in pneumonia, the outcome depends upon endurance. The scarring of the face is permanent and disfiguring in a characteristic manner.

In addition to supportive and protective measures, treatment of the skin to combat secondary bacterial infection is indicated. Isolation is most important, and this, together with immediate vaccination of all persons not recently vaccinated who have been even remotely exposed, should be rigidly enforced. In fact, the occurrence of any case of smallpox is reason for recommending vaccination to all persons in the neighborhood.

Vaccination.—In 1798, Jenner in England first reported that a local infection with cowpox (now effected by carefully prepared vaccine virus) would prevent smallpox. Today this statement remains irrefutable. There are those ignorant of the facts who still contend against vaccination and attempt to induce others to resist it, but no one who has had personal experience with smallpox questions the fact that unvaccinated persons exposed to the disease usually contract it, while those who have been recently and successfully vaccinated remain immune despite repeated exposure.

In this connection Sir William Osler's words deserve quotation:

> Some months ago I was twitted by the Editor of the Journal of the Anti-Vaccination League for maintaining a curious silence on the subject. I would like to issue a Mount Carmel-like challenge to any ten unvaccinated priests of Baal. I will take ten selected vaccinated persons, and help in the next severe epidemic, with ten selected unvaccinated persons (if available!). I should choose three anti-vaccination doctors, if they could be found, and four anti-vaccination propagandists. And I will make this promise neither to jeer nor to jibe when they catch the disease, but to look after them as brothers; and for the three or four who are certain to die I will try to arrange funerals with all the pomp and ceremony of an anti-vaccination demonstration.[1]

This challenge was never accepted. However, there have been instances in which zealots have voluntarily exposed themselves to the disease without vaccination and have died as a result. The old conclusion "cowpox is a complete security against the smallpox" is true, and the corollary may be added that there is no other security against smallpox.

Other arguments against vaccination have been based upon rumors of dangerous results. It is true that in the process of vaccination ordinary care must be exercised not to cause other infection of the skin. It is likewise true that about twenty-five years ago a small number of cases of tetanus were once caused by a certain supply of impure vaccine. With these exceptions, however, serious results of vaccination are practically unknown.

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[1] "Man's Redemption of Man," *The American Magazine,* December, 1910, p. 246.

Vaccination involves certain symptoms as it "takes." In children these are trivial, but in adults who have not been previously vaccinated there may be several days of high fever. Therefore, the best plan is to vaccinate first in infancy or early childhood. It should be repeated at about the ninth year when the symptoms will not be pronounced. Another repetition at about eighteen is advisable.

When an unvaccinated person is exposed to smallpox, immediate vaccination will usually prevent the disease or, if it does develop, the attack will be mild.

WHOOPING COUGH

Whooping cough is a disease which children in cities seldom escape. In infants, the condition is dangerous so that every precaution should be used to safeguard children from contracting the disease in their earliest years. As the age increases the danger diminishes; after the age of five there is much less cause for anxiety. Some cases occur in adults, and these are often not recognized as whooping cough.

The disease is due to a small bacillus which infects the mucous membrane of the trachea or windpipe. Here it develops in great numbers and, while producing but little inflammation, it inhibits the action of the microscopic *cilia* which normally propel the tracheal secretions toward the larynx. The peculiar cough is probably due to the inaction of these microscopic fingerlike processes.

After the incubation period, generally estimated at fourteen days, the disease begins, deceptively, with little to distinguish it from an ordinary cold with cough. The cough, however, is usually drier and perhaps more incessant than is that incidental to most common colds. Moreover, instead of subsiding or "loosening," it becomes "tighter" and more violent or jerky. About ten days after the onset a crowing "whoop" accompanies inspiration after a paroxysm of coughing. As the attacks continue to be more violent they often cause vomiting. It is three or four weeks after the first whoop before there is distinct subsidence.

By way of treatment, many drugs are used to lessen the violence of the paroxysms. Feeding must be adequate to make up for what is lost by vomiting, and in severe cases rest in bed is advisable.

Prevention lies chiefly in isolation of the early and suspicious cases since it is probable that contagion is slight or nil after four weeks from the onset, or two weeks after the first whoop. However, local rulings differ. Some health departments require children with whooping cough to wear distinctive arm bands and this measure has much to recommend it.

The value of vaccines for immunization is uncertain.

MUMPS

Mumps is a disease without mortality and its incidence is greatest in childhood. The condition is often regarded humorously because of the peculiar appearance of the patient. Nevertheless, a child with mumps may have high fever for some days together with distinct discomfort, and whenever the disease occurs in young adults the temperature may be extremely high and associated with more or less delirium. In males at or beyond adolescence, a certain percentage of cases have inflammation of one or both testicles which develops some days after the facial swelling has passed its maximum. This complication is extremely painful for a few days, and is often accompanied by very high temperatures.

The germ which causes mumps is not known, but it is believed to be contained in the saliva and to be spread chiefly by the mouth-hand-mouth sequence. The incubation period is fourteen to twenty-one days.

The disease is an inflammation of the salivary glands, usually of the *parotids,* which are situated about the angle of the jawbone in front of the lower part of the ear.

Treatment consists of isolation, and measures to lessen the discomforts. There is no specific, nor has any method of immunization been established.

COLDS

People do not always mean the same thing when they say that they "have a cold," some even applying the term to mild fevers of any sort. But a *cold* usually denotes either cold in the head, or cold in the larynx or windpipe. Both of these conditions are catarrhal inflammations, either of the mucous membrane of the nose, or of the mucous membrane of the larynx or trachea. Often the inflammation involves both, either simultaneously or in succession. It is probable that various bacteria are the causes of these catarrhal inflammations in different cases.

Cold in the head is the familiar event which comes on with sneezing, a sense of irritation in the nose resulting in a watery discharge, and obstruction of the nose due to swelling of the mucous membrane. Redness of the eyes is frequent. There may be a slight elevation of temperature, malaise, and some feeling of general illness. In two or three days the condition has passed its worst, and in a few days more it practically subsides. In proportion to the prevalence of the condition complications are rare, but there is a certain predisposition to ear disease and to disease of the sinuses.[2]

Cold in the windpipe is similar, except that hoarseness and cough are present instead of the nasal symptoms.

The desire of patients for "something to take for a cold" has not yet been adequately satisfied. Many patients have their own measures to which they invariably resort with relief, but none of these measures have met the requirements of the medical profession as having definite and general value. At the outset, a hot bath, a hot drink, and rest in bed with blankets sufficient to produce mild sweating are of some benefit. Certain sprays may give temporary relief. More important, from the medical point of view, is the avoidance of exposure and fatigue until complete recovery, since a neglected cold may be followed by pneumonia.

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[2] See section on Sinusitis in chapter entitled Diseases of the Nose and Throat, p. 443.

The total loss of time occasioned as a result of colds is large. They are communicable, and it is therefore the duty of those affected to take reasonable precautions against the infection of others by limiting their contacts and close associations to a minimum. Children and students should not attend classes; adults should avoid public gatherings and, so far as possible, should isolate themselves. While air transmission, especially after sneezing, is commonly understood to be responsible, it is possible that the nose-handkerchief-hand sequence of contact is also an important factor.[3]

TONSILLITIS

Tonsillitis is an extremely common disease and may be defined as an infection of one or both tonsils, the lymphatic structures situated at each side of the throat above the tongue. Probably various organisms cause tonsillitis, but in most cases the condition is due to streptococci. Enlargement of the tonsils predisposes to repeated attacks.

Fever, pain in the region of the tonsils when swallowing, together with redness and swelling of the tonsils constitute the chief symptoms. Ordinarily a small number of small white specks are seen on the reddened area. The fever and pain may be quite severe but both subside within a few days. Occasionally, an abscess forms near the tonsil (*peritonsillar abscess* or *quinsy sore throat*), causing greater pain until the pus breaks through the surface or is released by the doctor.

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[3] See section on Modes of Transmission in chapter entitled Infections by Bacteria, p. 172.

The treatment of tonsillitis consists of measures to diminish pain and to shorten its usual course. In repeated tonsillitis, thorough removal of the tonsils at a proper time is advisable.

Tonsillitis should cause no alarm, but as the condition may be followed by rheumatic fever and damage to the heart, repeated attacks involve some slight danger in addition to the suffering and loss of time incidental thereto.

RHEUMATIC FEVER

Acute articular rheumatism or rheumatic fever is an important and prevalent disease, distinctly different from certain other joint troubles popularly known as "rheumatism," but more properly called arthritis.[4] Rheumatic fever is a disorder in which fever is accompanied by successive painful inflammation of the various joints of the body during a course of approximately six weeks. But more important than the joint symptoms, painful as they are, is the fact that rheumatic fever is the most frequent of all causes of heart disease. The cause of rheumatic fever is not known with certainty, but a type of streptococcus is suspected. There is a probability that the infection enters through the tonsils. The inflammation of the joints does not tend to pus formation and there is complete recovery. The damage to heart valves, on the other hand, occurring in a considerable proportion of the cases, is a structural change which may cause permanent heart weakness.

Rheumatic fever occurs most frequently in late winter and early spring. It begins without warning, although in many cases there is a history of recent sore throat or tonsillitis. First there is severe pain, accompanied by swelling and inflammation, in either one or more joints, with a certain amount of fever. Sweating is apt to be profuse. The pain in each joint, after continuing for perhaps twenty-four hours, is likely to subside quite suddenly, leaving only a temporary stiffness. But the striking characteristic of the disease is that different joints are affected in this way successively. In other joint diseases, each individual joint remains inflamed for a longer time, and in many of these other forms of arthritis more or less permanent injury to the involved joints may result. This does not occur in rheumatic fever.

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[4] See section on Atrophic or Rheumatoid Arthritis in chapter entitled Orthopedic Surgery: Diseases of the Bones, Joints and Muscles, p. 397.

The condition is markedly benefited by the use of compounds of salicylic acid. In addition, rest in bed is necessary to diminish the likelihood of damage to the heart, or when such damage has already occurred, to lessen its extent.

Removal of tonsils or of other foci of infection is of considerable protective value, and is usually recommended to those who have had the disease in order to lessen the danger of subsequent attacks.

CHOREA OR ST. VITUS'S DANCE

Chorea is a disease chiefly of childhood, and is marked by the gradual appearance of involuntary, jerky, and awkward movements of the muscles. Its duration is about six weeks. The child is unable to sit still, is apt to drop things, and sometimes has difficulty in feeding himself.

There are some grounds for suspecting that chorea is due to the same cause as rheumatic fever, and its importance is likewise enhanced by the fact that it also involves danger of subsequent heart disease. The chief measure in its treatment is rest, to lessen the possibility of damage to the heart. Later, removal of the tonsils is advisable.

INFANTILE PARALYSIS

This disease, in medical terminology known as *anterior poliomyelitis* because it is a disease of the anterior portion of the spinal cord, is one of great importance, since it occasionally occurs in epidemics. Unfortunately, neither the cause nor the method of transmission is known, so that there are no established methods of control. Certain facts suggest its transmission by an insect, and the biting stable fly has been suspected, but positive evidence is lacking. It is more generally believed that the infection enters by mouth, contaminated raw milk having been suggested as a possible vehicle.

The disease begins with seemingly mild and brief fever, not particularly characteristic, until paralysis of certain parts of the body is noticed one to three days later. The few fatalities occur from paralysis of the muscles of respiration and not from the severity of the fever.

The extent of the paralysis varies. It may be very slight or exceedingly widespread. However, encouragement may be derived from the fact that there is recovery from the greater part of the paralysis so that eventual disability is less than is at first indicated. Skillful treatment is of great importance since, in growing children, the pull of unparalyzed muscles against those which are paralyzed tends to produce serious deformity; much can be done by means of splints and other apparatus to guard against such unfortunate results.

DYSENTERY, BACILLARY AND AMŒBIC

Dysentery is a diarrhea with bloody stools. There are two distinct forms, one caused by bacilli, and the other, a tropical disease, caused by a parasitic amœba.

Bacillary dysentery is not a very rare disease, and is more frequently the cause of diarrhea in childhood than is recognized. The source of infection and the manner of transmission are practically the same as in typhoid fever, notably by contaminated water supplies. In this form, high fever may be present in addition to the exhausting diarrhea.

There are two closely related varieties of bacilli of dysentery, and a serum treatment has some value in cases due to one of them.

The preventive measures are essentially similar to those in typhoid fever. A vaccine has been used, but not yet on a sufficiently wide scale to establish its efficacy.

Amœbic dysentery seems to be caused by contaminated drinking water, or sometimes by carriers. The disease involves less fever than bacillary dysentery, but the diarrhea may be extremely severe and persistent. A drug derived from ipecac has a value in the treatment of this condition similar to that of quinine in malaria.

MALARIA

Malaria is predominantly a disease of tropical and subtropical regions, but is by no means rare in parts of the temperate zone. It is transmitted only by the anopheles mosquito, and therefore may spread whenever one or more persons having the disease, even in latent form, go to a region where these insects are present. Thus, when laborers from Italy or other malarial regions are employed in a locality previously free from malaria, if the anopheles mosquito is then present in that locality malaria may occur. On the other hand, attacks of malaria are not entirely confined to the mosquito season, for when a person has once had malaria there is always a possibility that the symptoms may return even in cold weather, without a new infection by the insect.

The disorder is caused by a microscopic animal parasite in the blood. This parasite, when introduced into the body by the bite of a mosquito, multiplies in the blood by repeated subdivisions. Each parasite enters a red blood-corpuscle and there increases in size for forty-eight hours, at the end of which time it bursts from the corpuscle and divides into a number of parasites, each one of which enters another corpuscle and repeats this cycle. The chill is the effect upon the human host of the breaking up, at the end of each cycle, of the mature parasites and of the red corpuscles containing them.

Malaria is marked by the occurrence of chills every forty-eight hours. During the chill, although the patient feels cold, the temperature is above normal. Each chill is followed immediately by high fever, usually with headache and the other accompaniments of fever, and occasionally with nausea and vomiting. Within an hour, more or less, the fever is followed by profuse sweating and the discomfort subsides. On the following day the patient is practically well except for a certain feeling of weakness. On the third day, however, the attack, marked by chill, fever, and sweating, is repeated. These paroxysms produce increasing weakness the longer they continue. In the severer instances, most frequently seen in the tropics, there are variations from or additions to this simple course, marked by vomiting, a change in the urine ("black water fever"), or circulatory collapse.

The diagnosis is suggested by the regularly repeated chills, but, since certain other diseases may cause repeated chills, malaria is proved to be present only by a microscopic examination of the blood.

What has been said applies only to the commonest form of malaria, called *tertian malaria,* because if the first chill is taken to mark the first day of the disease the second chill occurs on the third day. The name is somewhat confusing since the actual interval between chills is two days and not three. Sometimes there are two sets of parasites in the same patient, so that a chill occurs every day. There are two other types of malaria, the *æstivo-autumnal* and the *quartan.* Both of these are spread in the same way, by the anopheles mosquito, but are caused by different parasites. The æstivo-autumnal form differs in its symptoms, in that there is a less pronounced subsidence of symptoms between chills. The quartan form is marked by attacks every seventy-two hours instead of every forty-eight hours.

Chronic or Latent Malaria.—Persons who live where malaria is prevalent sometimes have the parasites in their blood but do not have chills and fever, presenting instead only a certain amount of anæmia, malnutrition, and weakness. Enlargement of the spleen is usual in all forms of malaria.

As a rule, malaria can be promptly controlled by quinine properly administered. In the severer cases, however, the treatment requires careful direction. In the æstivo-autumnal form, remedies other than quinine are sometimes necessary. The quinine treatment should be continued for six weeks, even in the absence of symptoms, since earlier discontinuance may be followed by a return of the symptoms.

Preventive measures include: (1) prompt screening of all known malarial patients, so that the mosquitoes of the neighborhood cannot acquire parasites from them; (2) mosquito control; (3) the taking of quinine in small doses each night by all persons living in the malarial region.

TYPHUS FEVER

Typhus fever, also known as *ship fever* or *jail fever,* is a disease which throughout history has come into prominence in connection with wars and disasters. It is spread by the body louse and therefore becomes epidemic only when louse infestation is prevalent. At present, eastern Europe and Mexico are the chief regions in which it is occurring.

It is due to an organism found in lice which have drawn blood from typhus patients, and is conveyed only by the bites of such lice.

The disease is a severe fever accompanied by delirium and by a spotted rash. Its course is about two weeks, and it is more fatal in older people, in proportion to their age, than in youth. There is no specific treatment. Prevention lies in the control of lice and especially in delousing typhus patients.

BUBONIC PLAGUE, YELLOW FEVER, AND ASIATIC CHOLERA

These three diseases are not related in their medical aspects but they are mentioned together since for us they represent only remote dangers in distant parts of the world. While it seems unlikely that they will ever become prevalent in this country they are to be regarded somewhat as dormant volcanoes which may conceivably resume activity in epidemic outbreaks.

Bubonic Plague.—This was the "black death" which swept Europe in the fourteenth century, and in modern times there have been epidemics in various parts of the world, especially in southeastern Asia. It is transmitted by the fleas of rats, squirrels, and other small animals.

Yellow Fever.—Yellow fever is a very fatal disease of tropical cities. It is spread by the bites of a certain variety of mosquito. Fortunately, this mosquito is much more easily prevented from breeding than are the mosquitoes with which we are familiar; thus, yellow fever has been stamped out in most places where it formerly prevailed, the chief exception being the west coast of Africa.

Asiatic Cholera.—This disease has been prevalent in India throughout history and has occurred in epidemics in many other parts of the world. In 1832, in 1848, in 1854, and in 1873, it spread rather extensively throughout North America, entering through the ports of Quebec, New Orleans, and New York. It is caused by a short curved bacillus that is transmitted particularly in drinking water in the same manner as typhoid fever. Carriers undoubtedly play an important part in causing the disease to spread in new localities. It is for this reason that travelers in the far East are subjected to tests at ports of entry.

TETANUS OR LOCKJAW

Lockjaw is the convulsive disease, usually fatal, which results from the planting of the tetanus bacillus deep in the tissues. It results especially from gunshot wounds and from deep punctures with rusty nails which have lain in wet earth. After all such wounds, tetanus antitoxin should be injected, a measure which proved to be of great service during the late war.

RABIES OR HYDROPHOBIA

Though rare, this disease, which results from the bite of a mad dog, is of sufficient danger to justify preventive treatment. When *rabies* does develop it is invariably fatal.

If a person is bitten by a dog, the animal should not be killed, but kept in confinement under close observation for the following days to ascertain the presence of symptoms of illness. If the dog is killed, or dies, the brain should be examined by a method which will reveal the presence or absence of rabies.

A person bitten by any dog suspected of rabies should promptly receive a course of inoculations, which are harmless and of great preventive value.

TRICHINOSIS

Trichinosis is a disease which results from eating uncooked or underdone pork. Its cause is an animal parasite, contained in the pork, which enters the blood from the digestive tract and then becomes deposited in large numbers in the muscles.

The symptoms resemble those of typhoid fever, with high temperature and delirium for several weeks. Sometimes there is muscular pain. Prevention lies in cooking all pork sufficiently to kill the parasites. Most cases occur in foreigners who eat uncooked sausage.

CHAPTER XXIII

VENEREAL INFECTIONS

THERE are two very important infectious diseases which are conveyed, with few exceptions, through sexual contact, namely *syphilis* and *gonorrhea*. It should be emphasized that these diseases continue to exist almost exclusively as a result of the prevalence of illicit sexual intercourse. There are statistical reports indicating that a large proportion of all professional prostitutes have syphilis, and that almost all have or have had gonorrhea. It can also be affirmed that practically all men who have led promiscuous sexual lives have had gonorrhea, and that many of them have syphilis. Even greater emphasis should be laid upon the fact that, while these diseases primarily originate from sexual immorality, they are frequently conveyed secondarily to partners in marriage, so that not a few persons of both sexes who are wholly innocent of unchastity become infected. Campaigns have been conducted to educate the public in the requirements necessary to control these diseases, but unfortunately their results, if any, have not been such as to diminish the need for a fuller understanding of this serious problem by the public. It may be summarized in two essentials. First, all extra-marital sexual relations involve great danger of disease; secondly, marriage of any person of either sex who has had syphilis or gonorrhea involves danger of infection of the husband or wife, even though years may have elapsed since the symptoms have been active.

In view of the failure, hitherto, to control these diseases by educational programs, it is proper to mention that certain medical treatment, if resorted to within an hour or two after the exposure, is of value in diminishing the danger of infection.

In addition to syphilis and gonorrhea, there is a third venereal disease known as *chancroid,* which is common but is less serious. Chancroid produces painful ulcers on the genitals which are sometimes followed by abscesses in the groin, requiring surgical drainage. Healing, however, is completed within a month, and there are no after-effects such as those occurring in syphilis and in gonorrhea.

SYPHILIS

Syphilis is a disease which develops insidiously. Its early manifestations may seem unimportant, but if not controlled by vigorous treatment, and carefully observed, it may result in various unfortunate conditions, even as late as twenty years after the disease is first acquired. Of these, the least serious are rashes and other changes in the skin, some of which involve permanent disfigurement. The more serious results are syphilis of the nervous system, syphilis of the liver, syphilis of the heart and aneurysm. Syphilis is a common cause of miscarriage, and many infants born to syphilitic parents have what is known as congenital syphilis, causing serious illness in the first months of life and other syphilitic disorders in later childhood.

The organism which causes syphilis is called the *Spirochæta pallida.* It is a spiral or corkscrew-shaped microscopic thread having independent motility, and is not classed as a true bacterium but as an intermediate form, that is, one between the true bacteria and the animal parasites.

Syphilis is usually acquired from sexual contact, but kissing may also be the origin of many infections, since at a certain stage of the disease there are open sores in the mouth. Tobacco pipes and unwashed drinking cups have also been known to be sources of contamination; but the ordinary washing and drying of table utensils seems to be sufficient to render them safe.

The first sign of infection is the appearance of a hard but usually painless sore at the point of contact, usually about three weeks after the exposure. This persists for weeks or months with little tendency to heal. About six weeks later a rash in various forms appears on the surface of the body, particularly the trunk. At times it is well marked, but sometimes so inconspicuous as not to be recognized. Meanwhile, there are various symptoms of general illness such as slight fever, bronchitis, and often headache and pains in the bones of the legs. A curious characteristic both of the headache and of the leg pains is that they are worse at night. Not infrequently there is an irregular thinning of hair. Sores in the mouth are characteristic of the later months of the first year, and from then onward, even for many years, there is a tendency to extensive destructive eruptions of the skin. The late results of syphilis, in the central nervous system and in the various organs, include *meningovascular neurosyphilis,* which is a relatively acute illness marked usually by severe headache and often by mental symptoms; *locomotor ataxia*[1] and the permanent and ultimately fatal insanity called *general paresis*[2]; syphilis of the heart and arteries, sometimes leading to valvular disease and to aneurysm[3]; syphilis of the liver resembling *cirrhosis*[4]; and many other diseases of various parts of the body, even of the nose and throat, the ear and the eye. While undoubtedly there are many persons who acquire syphilis and escape these serious effects, there is no security to avoid these distressing and irremediable late results, unless effectual treatment has been received.

To determine the presence of syphilis there is a method of testing the blood which has definite diagnostic value.

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[1] See section on Diseases of the Spinal Cord in chapter entitled Diseases of the Nervous System, p. 352.

[2] See section on Syphilis of the Brain in chapter entitled Diseases of the Nervous System, p. 356.

[3] See section on Aneurysm in chapter entitled Diseases of the Heart and Circulation, p. 284.

[4] See section on Cirrhosis of the Liver in chapter entitled Diseases and Disorders of the Digestive System, p. 325.

Some specific drugs and injections are strikingly beneficial in the treatment of syphilis. Certain compounds of arsenic are known which act upon the organism that causes the disease, without producing harmful effects upon the body. Mercury in various forms has long been known to be effectual in overcoming syphilis. In a manner wholly unknown, compounds of iodine improve ulcers of the skin and other local manifestations. The course of treatment which must be followed, however, is a prolonged and exacting one, covering at least two years before any assumption should be indulged as to the permanent eradication of the disease.

Persons with syphilis often fail to understand the importance of systematic treatment. Usually, throughout most of the urgent period, they feel entirely well, so that it is difficult for them to realize the necessity for further treatment. There is often great difficulty in convincing them that they should continue under observation. If patients could see, as does every doctor, some instances in which untreated or insufficiently treated syphilis has resulted in irreparable damage, they would readily appreciate the disastrous effects if treatment is prematurely discontinued.

As is explained more fully in connection with gonorrhea, syphilis cannot be treated effectually save by a reputable physician. It is, therefore, the height of folly to heed advertisements, or apply to irregular practitioners for treatment.

GONORRHEA IN THE MALE

Gonorrhea in men is an infection which first affects the urethra or urinary passage and then ascends to the prostate gland where, if untreated, the inflammatory process continues in latent form for an indefinite period. It is in consequence of this elusive characteristic of the disease that the infection is sometimes unknowingly transmitted in marriage long after the disappearance of any symptoms.

Gonorrhea is caused by bacteria called gonococci which have been previously described.[5] These are present at the site of the infection in every person who has the disease in active form, and they also remain for an indefinite period subsequent to this stage.

The condition is acquired through sexual intercourse with a person harboring gonococci. The possibility of other modes of infection is subject to extreme doubt and can practically be excluded. There are, it is true, rare cases of infection of the urethra with bacteria other than gonococci, acquired innocently, but these are distinguishable by microscopic examination of the discharge, and their proportion is almost negligible. Gonorrhea of the eye, on the other hand, is the result of indirect transference of the infection as by hands or towels, and has often been the misfortune of physicians after treating gonorrheal patients.

Symptoms begin two to fifteen days after the entrance of the bacteria. First, there is a slight sense of irritation which quickly develops into a burning pain, more or less severe, in connection with the passage of urine. A sticky discharge from the urethra appears, soon increasing in amount and becoming thin grayish or greenish pus. Microscopic examination of this pus verifies the presence of gonococci. At some time from one to several weeks after the onset, there may be a marked increase in the symptoms connected with urination, indicating that the infection has extended to the prostate gland. But even if this does not occur, laboratory tests in most cases reveal involvement of the prostate gland.

When the disease is permitted to continue without treatment, or with only such treatment as the patient can apply, there is, after a week or ten days, some subsidence of symptoms, and in the following weeks the discharge lessens, so that after perhaps two months the patient may believe that he has recovered. However, a slight, sticky discharge persists, most noticeable on waking in the morning, and this continues month after month. It indicates that the disease is present in latent form in the prostate gland, and is still capable of causing trouble in a variety of ways. It may flare up again exactly as if a new attack of gonorrheal urethritis had been acquired. It may cause any of the complications, including gonorrheal arthritis. Moreover, it shows that the patient is still capable of transmitting the disease, and should therefore prohibit marriage. On the other hand, with proper treatment carefully followed, gonorrhea is usually curable, even to the extent that marriage may be permissible, if the final special tests, which should always be made, are found negative. In connection with this subject of treatment there are a number of points of public interest which should be emphasized.

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[5] See section on Important Bacteria of Disease in chapter entitled Infections by Bacteria, p. 175.

1. It is wholly impossible for a person with gonorrhea to treat himself effectually, as is so often attempted, with materials obtained from a drug store or by mail order. While drugs and injections have a certain usefulness in the treatment of this disease, they are of little value unless supplemented by the mechanical procedure known as massage of the prostate gland.

2. It should be understood that the treatment of venereal diseases is a favorite field for extortionate quackery, even to the extent of blackmail. "Institutes" and individuals that solicit patronage in the public press are to be regarded with suspicion.

3. Repeating for emphasis what has already been said, recovery must not be assumed to be complete merely from the subsidence of symptoms, but should be confirmed by special tests.

The individual who has, or fears he has, venereal disease should consult a physician who is known to be of good standing in his community. While it may be natural, in the desire for secrecy, to attempt to secure treatment from unknown sources, there is danger of falling into incompetent or designing hands. Every doctor of good standing is accustomed to professional secrets and can be relied upon to deal with the situation discreetly.

Treatment of gonorrhea includes general measures to diminish the discomforts of the earlier stages, and injections or irrigations which favor subsidence of the infection. Both of these somewhat lessen the danger of complications, but the chief measure in finally overcoming the disease is direct massage of the prostate gland, performed carefully and systematically until, by microscopic examination of secretions, it is finally evident that no infection or inflammation remains.

Complications of Gonorrhea.—There are numerous complications which may or may not appear. Many patients with gonorrhea either in the active stage, or later when it is considered to be inactive, have various complications. These include inflammations and abscesses of other parts of the genital tract, such as abscess formation about the urethra, abscess of the prostate gland, and *epididymitis,* which is a sudden painful swelling within the scrotum; these may subside spontaneously, but often require operations for relief. Other complications are gonorrheal joint disease, and gonorrheal infection of the eye. In a certain proportion of cases two unfortunate results may occur: (1) sterility, and (2) stricture or obstruction of the urethra.

Gonorrheal arthritis is one of the most unfortunate results of the disease, since in its worst forms it leads to permanent crippling. During the attack of gonorrhea, or years subsequently, one or more joints of the body become swollen, inflamed and painful. The inflammation begins in much the same way as in rheumatic fever,[6] but with this difference, that while in rheumatic fever the painful joints soon recover, those of gonorrheal arthritis remain painful and stiff for a long period, and may even be damaged permanently.

Stricture of the urethra is a narrowing of the urinary passage, usually due to gonorrhea, which first gives symptoms only many years after the infection. There is increasing difficulty in discharging the urine which necessitates instrumental treatment.

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[6] See section on Rheumatic Fever in chapter entitled Infections, p. 241.

Sterility in the male is due to gonorrhea more than to any other cause, and is especially likely to be a result of epididymitis. Many sterile marriages are directly attributable to previous gonorrhea in the husband.

GONORRHEA IN THE FEMALE

Gonorrhea in women, like that in men, is an infection by the gonococcus which involves both the urinary passage and the genital tract; but in the female the manifestations referable to urination are usually less pronounced. In fact all of the early symptoms tend to be milder in women than in men. There is, however, inflammation about the urinary opening and a discharge of pus containing gonococci both from the urinary passage and from the outlet of the uterus. Gonococci survive in the secretions long after all symptoms cease.

Infection of the eyes of infants by the secretions of the mother as the child's head passes through the genital passage in the process of birth has, in the past, been the cause of many cases of blindness. But a preventive treatment is now routinely applied to the eyes of all newborn infants which as a rule is completely effectual.

By far the most serious complication of gonorrhea in women is *gonorrheal salpingitis* (pus-tube), an infection of the fallopian tubes which lead from the ovaries to the uterus. While the gonorrheal infection may immediately extend upward to these structures, it is usual for this not to occur until months or even years after the first infection. Its beginning is generally a well-marked event, manifested by fever and sudden, severe pain in the lower abdomen. It constitutes a serious illness in which the patient is confined to bed for a period of weeks and for a long time the symptoms may repeatedly return. Usually, it subsides without requiring surgical treatment, but if abscess formation is present an operation may be necessary. Even after the acute symptoms have subsided, gonorrheal infection of the fallopian tubes and of the pelvic peritoneum usually results in permanent ill-health. Sterility is almost inevitable. The treatment indicated is prolonged rest in bed and close observation by the doctor to determine whether or not operative procedure is necessary. Ordinarily, with prolonged rest, hot applications and douches, and other treatment, surgery can be avoided, or at least deferred until a more favorable time. In a certain proportion of cases in which recovery from the acute attack occurs, persistent discomfort from chronic inflammation follows. This is often relieved by surgery.

CHAPTER XXIV

DISORDERS DUE TO EXTERNAL CONDITIONS AND TO POISONS

SUNSTROKE (HEATSTROKE) AND HEAT EXHAUSTION

Extreme exposure in hot weather is the cause of two distinct conditions. The first, known as *sunstroke* or *heatstroke,* is a high fever accompanied by hot, dry skin, which, if unrelieved, leads to unconsciousness and death. The second, known as *heat exhaustion,* is a state of collapse with cold, clammy skin, cold hands and feet, rapid pulse, and perhaps faintness. It is important to recognize the distinction between these two forms of illness due to heat, since the emergency treatments are entirely different.

Heatstroke develops suddenly, usually in persons engaged in some active occupation, as in soldiers on the march. The first warning is the cessation of sweating. Then, there is a feeling of fever together with shortness of breath, and the subject usually falls to the ground, perhaps unconscious. The treatment necessary to save life is immediate reduction of the body temperature, which is best effected by bathing and rubbing the entire surface of the body with cold water. If the patient is able to drink, cool water should be given in generous amounts. In severe cases, certain measures which only the physician can apply are of supplementary value. By way of prevention, drinking plenty of water in hot weather is important, and cessation of sweating should always be interpreted as a signal to discontinue bodily activity, to drink more water, and, if possible, to take a bath in water cooler than the body temperature.

Heat exhaustion seems to be a condition of fatigue from continued discomfort and sweating. Loss of appetite and poor sleep incidental to hot weather, as well as the use of alcoholic drinks, are contributory factors. In contrast to the high fever of heatstroke, the temperature in heat exhaustion is normal, or more commonly subnormal. In these patients the cold water bathing used for heatstroke is harmful and dangerous. External heat, hot drinks such as tea, coffee or cocoa, and rest in bed are indicated.

Aside from these two forms of definite heat prostration, continuous hot weather is a cause of debility and particularly of disorders of digestion. Young children are particularly apt to be seriously affected.

CAISSON DISEASE

Workers in modern tunneling and diving operations, who are subjected to high atmospheric pressures in compressed air during their labors and who return afterward to normal atmospheric pressure, are often affected by severe pains and cramps in the muscles, dizziness, and other symptoms which may persist for a number of days. Prevention lies in gradual changes in atmospheric pressure. Thus, under well-regulated conditions, before resuming their normal course, the workers are placed in a compression chamber in which the atmospheric pressure is reduced slowly and gradually. When symptoms occur, the patients should be returned to high atmospheric pressure and then subjected to a gradual decompression.

MOUNTAIN SICKNESS

As all mountaineers and aviators know, there are symptoms of shortness of breath on slight exertion at high altitudes. In mountain climbers these symptoms are only a source of inconvenience, and gradually cease after a number of days in the mountains. The condition is of medical significance only in persons who, because of cardiac or other diseases, are already subject to difficulty in breathing. Such persons should avoid high altitudes.

ELECTRIC SHOCK

Electric shock, such as is sometimes received from live wires, may be instantaneously fatal, as in electrocution. There are, however, cases in which resuscitation is possible. The point to be emphasized is that the most marked effect of the electric current is paralysis of breathing, and this may occur despite the fact that the heart still functions. Therefore, artificial respiration as applied in drowning [1] is indicated.

EXPOSURE

Prolonged exposure to cold causes characteristic symptoms, ending in what is known as "freezing to death." After a period of uncomfortable consciousness of the cold, there comes a state of apathy and uncontrollable drowsiness. If an individual has passed into this state of insensibility a short time before being discovered, there is still hope of resuscitation, by the application of any measures which may arouse him, such as friction to stimulate the circulation, the infliction of physical pain, or, if necessary, artificial respiration.[1] It is generally advisable that these measures be carried out in a cool atmosphere, since bringing the patient suddenly into a warm room is likely to increase the danger.

Local frostbite is indicated by whiteness of the skin. Rubbing with snow or with ice water until the color returns is the usual first-aid measure. In manipulating frozen ears or fingers, however, care must be taken not to injure them. If the circulation cannot be restored, the affected part subsequently becomes gangrenous, the tissues becoming blackened and finally falling off. Such gangrenous frozen tissue should be kept clean and dry.

DROWNING

Drowning is a form of suffocation due to filling of the lungs and air passages with water. Consciousness is lost and respiration ceases, while the heartbeat may still continue for a time. In this period proper treatment may save life.

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[1] See section on Drowning, below.

The first step in treatment is to place the patient face downward across some high object, such as a barrel, so that the water in the lungs may gravitate through the windpipe and out of the mouth. At the same time artificial respiration should be applied. The *Schafer method,* which is superior to the mechanical pumps so extensively employed, is as follows: As mentioned, the patient is placed face downward, resting upon some high object supporting the abdomen, with the neck distinctly lower than the chest. The operator then places his hands upon the patient's lower ribs, one on each side of the back-bone, and presses downward for three seconds, by leaning his weight upon his hands; the pressure is then released for two seconds, after which the process is continuously repeated in regular rhythm. The object of the pressure is to compress the abdomen so as to force the diaphragm upward; when the pressure is released the diaphragm will descend and a certain amount of air will enter the lungs. If the treatment is successful, spontaneous breathing movements will soon begin. It is usually advisable to continue artificial respiration for an hour before abandoning hope. It is best that several persons be at hand to relieve each other in carrying out this treatment.

SNAKE BITE

The bite of a venomous snake is comparable to a hypodermic injection of its poison. Therefore, the objects of treatment are: (1) to remove the injected poison as promptly as possible by enlarging and draining the wound; and (2) to delay so long as possible the absorption of the poison into the body from the point of injection. If the bite is in an arm or leg, a tourniquet should be applied fairly tightly. Then, a large deep cut, or two intersecting cuts, should immediately be made where the fangs have entered. Sucking out the poison, by suction applied with the mouth, is a usual procedure, and is entirely safe if there are no open sores in the mouth. Bleeding from the wound should be encouraged, and massaging toward the wound so as to squeeze out the poison is advisable. Applying permanganate of potash to the wound may be of some value, but the use of this remedy should not distract attention from the need for free opening and the use of mechanical means to remove as much of the poison as possible.

The object of the tourniquet is to delay the absorption of the poison. Its proper management is a delicate matter, since too early removal of the tourniquet increases such absorption while if it is too tightly applied and too long in position it may cause gangrene of the limb. The tourniquet should not be so tight as to stop the pulse. According to general medical opinion, the widespread practice of giving large amounts of whisky for snake bite is harmful.

The action of the poisons of the rattlesnake, the copperhead, and the cottonmouth moccasin are all similar, principally destroying red blood-corpuscles. The poison of the cobra, on the other hand, and that of our native but comparatively rare coral snake, act not on the blood but on the nervous system. Snake bite in this country is seldom fatal.

Antivenins are serums developed as antidotes for the various venoms exactly as antitoxin is produced as an antidote for the poison of diphtheria. The appropriate antivenin should always be used if it can be obtained.

"GAS" OR CARBON MONOXIDE POISONING

Breathing of illuminating gas, and breathing the air of small closed garages in which the motor of a car is running, have the same effect. Carbon monoxide gas, when it enters the lungs, combines with the hemoglobin of the red corpuscles of the blood more powerfully than does the oxygen of the air. Thus, the blood loses its power to carry oxygen, in proportion to the amount of gas inhaled. Consciousness may be lost and death may follow.

Resuscitation is favored by artificial respiration, applied as described under Drowning.[2] More effectual is the administration of inhalations of oxygen, or especially of oxygen with a certain admixture of carbon dioxide. Only in such cases as are treated relatively soon after consciousness is lost may survival be expected.

FOOD POISONING

Many attacks of diarrhea, with or without vomiting, especially if they occur simultaneously in two or more people who have eaten of the same food, must be attributed to food poisoning. While such attacks are usually not dangerous and recovery soon takes place, there are occasional instances when they have serious and even fatal results.

Bacterial decomposition of food substances produces poisons, which are taken into the body when the food is eaten. The symptoms that follow are not an infection of the body by the bacteria but only a poisoning of the body by bacterial products previously formed. Boiling or otherwise heating these food poisons renders them harmless. Therefore, if foods suspected of having been kept too long are thoroughly cooked immediately before they are eaten, the danger of food poisoning is considerably reduced.

In most traceable instances, something improperly canned or something which has been kept too long in a defective refrigerator is responsible. Less common cases of another sort are those in which some poison, such as arsenic or rat poison, has become mixed with food, or in which a poisonous plant or mushroom has been eaten. In some individuals, shellfish or strawberries cause skin rashes or asthma, because of a peculiar susceptibility of the particular person.

In the treatment of food poisoning vomiting should be induced and free action of the bowels secured. Supportive measures should be adopted as necessary. There is an antitoxin which seems to possess certain value for the most dangerous forms.

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[2] See section on Drowning in this chapter, p. 261.

LEAD POISONING

Lead poisoning is acquired in connection with certain industries, painters, plumbers, and rubber workers being chiefly affected. Ship scrapers, who are liable to inhale the dust of red lead as they work, are so often victims that in most shipyards masks are provided. Formerly, lead poisoning frequently resulted from drinking water drawn through lead pipes; old-fashioned typesetters were also subject to it; but these causes are now rare. Of late, the use of a lead compound in motor gasoline has raised the question whether this may not be a source of danger to garage workers and to the public at large.

Lead is a substance which may enter the body gradually in repeated small amounts without causing immediate symptoms; but when it has accumulated through months or years, it may suddenly cause severe symptoms. The commonest of these is painters' colic or cramp-like, abdominal pain. In some of the worst cases there is delirium. In others, there is wrist-drop, a temporary paralysis of the forearms.

Certain curious facts are known as to the behavior of lead in the body. It tends to deposit in insoluble form, especially in the bones, but by certain treatments it may be made to change into more soluble salts which may be thrown off by the kidneys and bowels. On the other hand, the circulation of these soluble salts in the body in large amounts appears to be the cause of the acute symptoms. Thus, the plan of treatment is, first to favor insolubility until the pains have ceased, and then, very gradually, to induce a change to solubility.

Lead poisoning should be prevented. To accomplish this, painters should be warned of the danger of inhaling paint dust in scraping and sandpapering paint. Plumbers, painters, and rubber workers should likewise understand the importance of washing the hands before eating. In some old houses, lead plumbing is still seen, and persons who habitually drink water which flows through lead pipes accumulate amounts of lead in their bodies which sooner or later prove dangerous.

ALCOHOLISM

Ordinary intoxication requires no description except to mention that, among the many variations which seem to depend upon the temperament of the individual, there is one, known as *pathological intoxication*, which borders on temporary insanity, sometimes leading to violent and dangerous actions. Chronic alcoholism is a form of drug addiction which leads to great deterioration of the personality.

Delirium tremens is a violent mental disorder which occurs occasionally in continuously heavy drinkers, and is characterized by the visualization of imaginary sights (*hallucinations*), usually of a terrifying nature. There is also a state of tremulousness. The condition may lead to unconsciousness and death, but is usually survived with complete recovery.

A form of chronic alcoholism is that called *dipsomania,* in which the drinking is not continuous, but is marked by occasional uncontrollable impulses to drink heavily.

While in most instances the mental deterioration of the chronic alcoholic does not amount to actual insanity, it does in some, as is demonstrable by the fact that in about ten per cent of the cases admitted to hospitals for the insane alcohol has been the cause.

DRUG HABITS

Far worse than chronic alcoholism, which is really one form of drug habit, is addiction to narcotics, notably to morphine, heroin, or cocain. These, and also many other drugs of less potent action, have the unfortunate property of creating a craving to take more, even after a few doses; this craving, if satisfied, very soon becomes uncontrollable and permanent. Therefore, physicians are always on their guard in prescribing these drugs repeatedly, knowing that it is better for a patient to endure temporary pain than to have his life wrecked by a drug habit.

Addiction to opium has long been prevalent among Orientals. Latterly, however, there has been an increase in this country of the more serious addiction to morphine, heroin, and cocain. Although the sale of these drugs is now forbidden by law, they are smuggled through illegal channels, and it is said they are readily available to all who can pay for them. Since the cost of a continuous supply is more than most addicts can earn in ordinary occupations, it is believed that many are drawn into criminal activities by the need of satisfying their cravings for drugs.

Drug habits develop in various ways, but often with an almost unbelievable insidiousness. One common story is that a thoughtless hospital attendant or pharmacist's assistant has begun by helping himself to harmless looking tablets for headaches or for some other minor symptom until, before he has realized it, he has become unable to stop. In painful diseases which are of more than brief duration, there is always danger that the patient's appeals for temporary relief by morphine may overcome the physician's better judgment until addiction is threatened. Usually, however, development of the craving under such circumstances becomes evident before it is yet beyond control. Occasional cases develop in doctors; knowing this, most members of the medical profession make it a rule never to take morphine unless it is administered to them by another physician.

There are reports that habit-forming drugs are passed about among irresponsible youths of both sexes. Just how prevalent this practice may be can scarcely be determined. It should be made clear to all young people, however, that even a single experiment with such drugs is infinitely more dangerous than similar experiments with alcohol, and that repeated use of them inevitably leads to the end of all usefulness and happiness.

The early symptoms of drug addiction are confined to the cravings for another dose of the drug. These soon become imperative. Later there is deterioration of character, and great suffering unless the drug is taken frequently and in increasing amounts.

Addiction to narcotics is best treated by admission to a special institution for a long period. Even then a permanent cure is doubtful.

In addition to morphine, heroin, and cocain, ether, chloroform, and the milder sleep-producing and headache-relieving drugs are to some extent habit forming.

CHAPTER XXV

DISEASES OF THE HEART AND CIRCULATION

Although the diagnostic and therapeutic aspects of heart disease in themselves present comparatively little difficulty to a well-trained physician of wide experience, the subject is more complex when considered from the human standpoint. This is largely due to the fact that at all ages the mortality from disease of the heart is great, and also because it is one of the commonest human phobias. Curiously, the majority of those who entertain this fear are not victims, as most of the sensations and symptoms which usually direct attention to the heart are not symptoms of disease.

While it is the part of wisdom for any one who suspects abnormality to consult a physician rather than to brood upon the condition without advice, it may be helpful to mention certain symptoms ordinarily believed by the layman to indicate organic disease of the heart which are much more common in its absence than in its presence.

Fainting attacks, such as occur so frequently in adolescents and young adults, especially of the female sex, may suggest heart disease; and while it is wise, on general principles, to have an examination for such attacks it is only rarely that disease of the heart is found in these patients, unless other symptoms are also present. Fainting is believed to be due to a temporary lack of blood supply to the brain, caused in most cases by a relaxation of the blood-vessels, and not by inadequate function of the heart.

Palpitation, or conscious sensation of the heartbeat, is probably the commonest symptom which causes worry. Under completely normal conditions one is not conscious of the heartbeat, but a large proportion of all people have, at times, some sensation in connection with the heart's pulsations, especially when lying on their left side. The more the attention is directed toward this the more it is felt. Nervous people are more prone to have such sensations than are the more phlegmatic. Tea, coffee, and tobacco, and also disorders of the stomach, which lies just below the heart, are often factors in producing the condition. While in organic disease of the heart palpitation is often present as one of the symptoms, and occasionally is the predominant one, the great majority of patients who complain of this and similar sensations, and of nothing else, have no organic disease.

Pain in the region of the heart, except *angina pectoris* in older people, which will be described separately, is to be regarded in the same light as palpitation, as this symptom is but rarely a concomitant of heart disease. Such pain is curiously prevalent in soldiers, and is usually regarded as a reaction of subconscious fear. This subject will be discussed subsequently in this chapter under Neurocirculatory Asthenia, but it is mentioned here to emphasize the fact that painful or uncomfortable sensations, though common, are rarely connected with organic disease of the heart save in old age.

Most ordinary irregularities of the heart are harmless, although there are certain common forms that deserve medical attention. Inequalities of force and rate which bear a relation to the breathing are to be regarded as normal phenomena. Persons who notice a thump at the end of a deep breath without other symptoms have no more reason for fear than have others with palpitation. The occasional "skipped beat," or interruption of a rhythm otherwise regular, is of practically no consequence. The most frequent type of irregular heart action having medical significance is *auricular fibrillation,* to be explained later, and this has the characteristic of total lack of regular rhythm. Unusual slowness of the heart rate is a peculiarity of certain individuals, particularly those who are tall and thin, and sometimes has a familial tendency. It is not to be considered as pathological. In convalescence from disease and after childbirth the pulse is often unusually slow. Rare instances of very slow pulse rates, usually in the neighborhood of forty per minute, are due to a disease known as *heart-block,* to be discussed later.

Temporary rapidity of the heartbeat is of three kinds. The first and commonest is purely an emotional reaction to fear, anger, or other excitement. The other two varieties, *paroxysmal tachycardia* and *auricular flutter,* are discussed separately.

The great majority of those who seek medical counsel because of supposed heart symptoms which cause anxiety will receive assurance that worry is not justified. The symptoms so far described, when they exist as the chief complaint, are not the first ones to which inquiry is directed when a physician suspects heart disease.

Breathlessness on exertion, as in stair climbing, is by far the commonest symptom of organic disease of the heart. When a person notices that he is getting out of breath more easily than in the past, and more than others after similar exertion, incapacity of the heart may be one of the causes. There are many others, varying from a simple condition of "out-of-training" to obesity, anæmia, and emphysema of the lungs, but in any pronounced tendency to shortness of breath a physician should certainly be consulted, and when there is complaint of this symptom the examination will always include investigation of the heart.

Swelling of the feet, more pronounced at the end of the day and usually occurring in connection with shortness of breath, is another symptom which occurs as an effect of an incompetent heart. This statement should be qualified by calling attention to the fact that it is only a rather unusual degree of painless swelling known as edema which is meant. The distinguishing mark of edema of the feet is that, if the swelling is pressed upon firmly with the thumb, a deep depression remains for some minutes.[1] There are, however, other causes of edema of the feet, notably *varicose veins,* anæmia, and certain other diseases. Tight garters may also cause edema.

Persons who in the past have had rheumatic fever, chorea, scarlet fever, diphtheria, syphilis, or frequent attacks of tonsillitis are among the majority of those who have heart disease before the age of forty. In older persons, arteriosclerosis is a factor of increasing importance; in other instances, hearts ordinarily competent for normal work develop symptoms of disease because of degeneration of the kidneys or high blood-pressure, both of which throw an excessive amount of work upon the heart.

DISEASES OF HEART VALVES

In heart disease prior to old age it is the valves that are most commonly affected. As mentioned,[2] the valves of the heart are thin, flaplike structures of fibrous membrane which control the inlets and outlets of the ventricles, so that the blood may flow freely through them in the proper direction but not in the reverse direction. When one of these valves becomes shrunken or rigid so that it no longer completely closes the orifice which it is its function to close, or thickened or rigid so that it does not open properly or sufficiently when it should, the condition is called valvular disease of the heart. Such a disorder usually results from infections, like rheumatic fever and scarlet fever, which cause an inflammatory or ulcerative process in one or more of the valves. As a result of this, the edge of the valve may be more or less destroyed, causing leakage. Subsequently, this ulceration heals by the formation of scar tissue which sometimes connects opposite valve flaps. The final outcome is a narrowing, or partial obstruction, of the valve-opening.

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[1] It has been the author's experience that of the large proportion of women patients who affirm that they have swelling of their feet at the end of the day, only a very small proportion have real edema.

[2] See section on The Heart in chapter entitled The Heart and Circulatory System, p. 50.

The immediate effects of disease upon the heart valves may be slight, and may seem less significant at the time than, for instance, the joint symptoms of rheumatic fever; but, while the joint symptoms are temporary and recover completely, the injury to the heart valve is permanent and, according to its extent, causes a certain degree of incapacity for hard work throughout the remainder of life.

The inflammation producing such ulceration of a heart valve is called *acute endocarditis.* While there is no direct curative treatment for it, it is believed that the extent of the damage is lessened by complete rest in bed until the ulceration has healed. Patients and their relatives are often unable to understand why a physician advises continued rest in bed after an attack of rheumatic fever or scarlet fever has apparently subsided. Probably the majority insist upon getting up before the doctor gives his consent, not appreciating the fact that they are in danger of becoming permanently incapacitated by heart disease, and that rest in the early stage is the only measure known to lessen the degree of such subsequent incapacitation.

The final anatomical result upon the heart valve is accomplished only several months later. If this involves leakage, it is called *insufficiency* or *regurgitation.* If it involves partial obstruction, it is called *stenosis.* Both insufficiency and stenosis may be present in the same valve, it then being unable either to close or to open completely. The *mitral valve* is the one most frequently affected, so that the conditions known as *mitral insufficiency* and *mitral stenosis* are the commonest valvular diseases. The symptoms of these conditions may be readily understood if compared with ordinary mechanical or hydraulic processes. When the mitral valve is insufficient and leaks, with each beat of the heart there is a back-flow of blood from the left ventricle into the left auricle, and in consequence a continued overfilling of the veins and capillaries of the lungs. This results in what is known as *passive congestion* in the lungs, which is unfavorable to complete exchange of oxygen and carbon dioxide between the blood and the air in the lungs. The patient becomes easily out of breath, and tends to have a bluish color, as blood which is deficient in oxygen is darker and less red than normal blood.

Mitral stenosis or obstruction also causes passive congestion of the lungs, since the flow of blood from the lungs through the left auricle to the left ventricle is impeded. When there is passive congestion in the circulation of the lungs, the right ventricle works harder in an attempt to pump the blood forward despite this increased resistance. To a certain extent it succeeds, but if the disorder is too great the right ventricle also weakens, with the result that passive congestion likewise appears in the veins leading to the right auricle and in the various parts of the body supplied by these veins. When this occurs there is edema of the feet, enlargement of the liver, and sometimes *ascites,* which is a collection of fluid in the abdominal cavity. In this event a gallon or more of fluid may be present giving a sense of weight as well as of distention.

The aortic valve occupies second place in cases involving abnormalities of the heart, disease of the pulmonic and of the tricuspid valves being rare. *Aortic insufficiency* or leakage is far more frequent than *aortic stenosis* or obstruction. When the aortic valve leaks, but is not obstructed, each heartbeat pumps blood into the aorta as usual, but the pulse is felt to be not "sustained." In other words, the flow of blood in the arteries is more intermittent or spurting than under normal conditions. From leakage of the aortic valve, some blood drops back into the left ventricle,[3] and as a result it must beat harder or faster to supply the body with sufficient circulation of blood. If the ventricle is able to do this, the symptoms of aortic insufficiency are not pronounced; but if the ventricle weakens from overwork, passive congestion of the lungs and breathlessness appear, as in mitral disease.

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[3] According to certain evidence, the peculiarities of the pulse in aortic regurgitation do not seem to be caused directly by the leakage, but rather by an accompanying relaxed state of the arteries not as yet thoroughly explained.

When once established, the leakage or stoppage of any valve is permanent, there being no provision for growing a new valve. Nature, however, attempts to meet the exigency in another, limited way. A heart handicapped by imperfection of any of its valves immediately begins to pump harder with its muscles, and these muscles, which form practically the entire heart, undergo development, just as do other muscles when their activity is continuously increased. The heart becomes larger and capable of greater muscular action, the scientific term for such enlargement being *hypertrophy*. If the valvular injury has not been extreme, the handicap caused by leakage or stoppage of the valve is counterbalanced by such increased pumping power of the heart muscle; and when, despite the damaged valves, the circulation becomes sufficient by reason of this overdevelopment of the heart muscle, the valvular disease is said to be "compensated." As a rule, however, the compensation is seldom sufficiently complete to furnish the same reserve power in strenuous activity as is present in a normal heart.

In determining the existence of disease of a heart valve, doctors depend less upon the symptoms than they do upon peculiar sounds called *murmurs;* these are heard by listening with a stethoscope. The blood, in flowing through partially obstructed openings, or in leaking back through valves which should normally close tightly, produces rushing, rumbling, or blowing sounds. In certain conditions, these so-called murmurs are present in the absence of organic disease; but the murmur produced by each disease of each of the separate valves has its peculiar characteristics by means of which the type of valvular disease may be recognized. Increase in size of the heart and other findings in the examination are also significant, especially as evidence of the extent of the impairment.

However, the symptoms and their severity furnish perhaps the most reliable diagnostic criteria as to the gravity of the condition. Of these, the most important is breathlessness on exertion. Often the increased force of the heartbeat is interpreted by the patient as palpitation, and sometimes this is the chief complaint. Faintness occurs occasionally, especially in diseases of the aortic valve. Swelling of the feet is sometimes observed before other symptoms are pronounced, but this is more frequently a late symptom.

When, in a child or young adult, deformity of a heart valve results from rheumatic fever or other disease, the effect upon life and usefulness depends upon the extent of the damage. If this is relatively slight it may cause no symptoms. Such cases are found on examinations for insurance or for military service. At the other extreme, there are instances of such serious impairment that the individual is unable to leave the bed and may die soon after the disease has been contracted. In most cases the result lies between these two extremes, permitting a certain amount of activity but requiring a degree of moderation in physical exertion to prevent a recurrence of symptoms. The majority of persons with valvular heart disease have a permanent partial disability, because of breathlessness if they attempt any activity beyond that possible for them. However, if their lives are carefully regulated so as to avoid undue exertion, they may continue to live from youth through maturity without any increase in disability until advancing age exerts an unfavorable influence. On the other hand, if overexertion is attempted, the symptoms increase, resulting in what is known as an attack of "broken compensation." This always demands complete rest in bed for some weeks; and even though such precaution be taken, the patient sometimes succumbs. In many instances, there are successive years, each one increasing the disability. Sooner or later, all exertion becomes impossible, the patient being totally incapacitated, or death occurs in an attack of broken compensation before there is complete disability. Patients who have acquired serious valvular heart disease in childhood are very apt to die in early adult life. Others who have had valvular heart disease throughout their early lives often die in later middle age.

Contrary to prevailing popular opinion, death resulting from valvular and most other forms of heart disease is usually not sudden, but occurs rather from gradual exhaustion as a sequel to continued breathlessness.

The treatment of valvular disease of the heart lies primarily in regulation of the mode of living, so as to prevent any activity out of proportion to the patient's power. In other words, it must be recognized that the heart is permanently handicapped, and that therefore the activity of the body as a whole must be proportionately reduced. Accordingly, it must be determined how much each patient may do, and within what limits his life must be regulated. Such medical supervision and adaptation by the patient to the requirements set by the disease of his heart, rather than the administration of medicine or other active treatment, are the essentials of management in any given case. Something is also to be gained by gradual and systematic exercise which aims to develop the heart, just as any other muscle is developed. If carefully conducted, such systems of exercise are of assistance in enabling a patient gradually to do somewhat more. On the other hand, every person with heart disease must be explicitly cautioned against overexertion at any time. Running for street cars is typical of the commonest source of attacks of broken compensation; and excitement and violent emotions are fully as unfavorable as physical overexertion.

One unfortunate phase of the course of valvular heart disease is that, when a valve has once been affected, the patient is subject to repetitions of the acute endocarditis; a valve which has been impaired but little in the first attack may be damaged more and more by subsequent attacks. There is strong evidence that infections which attack heart valves usually enter through the tonsils. Therefore, if slight disease of a heart valve is present, especially in childhood, removal of tonsils is to be recommended as a safeguard against reinfection.

In addition to regulation of life so as to make the best of a definite handicap, there are certain drugs which have the effect of improving the action of heart muscle. However, these are chiefly indicated as a supplement to the regulation of the general mode of life and as a measure of relief in broken compensation, during and after which careful and sometimes complicated medical treatments are of distinct benefit. But the most effectual way of prolonging the life of a patient with disease of a heart valve is the prevention of such attacks by limiting the physical activity.

DISEASE OF HEART MUSCLE

Myocarditis, or disease of heart muscle, occurs in different forms. After acute diseases, notably diphtheria, there may be symptoms due to deterioration of the heart muscle which are either temporary or permanent. But by far the most common form of heart disease due to injury of the muscles is the degeneration of heart muscle developing in old age in consequence of arteriosclerosis, or sometimes at an earlier age from syphilis.

The heart muscle can remain normal only if it receives an adequate blood supply through the coronary arteries, which are given off from the beginning of the aorta and lead into the muscular walls of the heart. If, in consequence of arteriosclerosis or of other disease, there is a lessening of the blood flow through the coronary arteries, the fibers of the heart muscle undergo degeneration, and there is an increase of scarlike tissue between the muscle fibers. As a result, the heart pump becomes less powerful, and on exertion the patient has symptoms like those of valvular disease. The disability usually occurs gradually, but as in valvular disease, if violent exertion is attempted, an attack is precipitated in which there is extreme breathlessness and real danger of death. Therefore, practically the same course of treatment is indicated in degeneration of the heart muscle as in valvular disease. If a restricted mode of life is judiciously followed, symptoms do not ordinarily occur, but if the equilibrium is upset, periods of rest in bed become necessary. If restrictions are disregarded, the disability increases and pronounced overexertion or excitement may prove fatal. The medical treatment is similar to that of valvular heart disease.

ANGINA PECTORIS AND CARDIAC ASTHMA

Many elderly people are subject to heart attacks, some of which are not fully understood. The most important of these is known as *angina pectoris,* which in typical display is an extremely severe pain in the chest of sudden onset, usually precipitated by excitement or exertion. There are also atypical instances in which the pain is referable to the stomach. As this form is often accompanied by vomiting, it is sometimes mistaken for violent indigestion. In certain cases of angina pectoris there is pronounced arteriosclerosis of the coronary arteries, and it is widely held that the attack may be due to a closure of the coronary arteries.

This is the chief type of heart disease in which sudden death occurs. Moreover, it is a form in which there is frequently nothing either in the symptoms between attacks or in the physical examination to suggest a basis for exact diagnosis. It happens occasionally that a person who has had no previous symptoms, and who has recently passed a physical examination for insurance or for some other similar purpose, dies suddenly, and the post-mortem examination shows no other cause of death than some abnormality of the heart. However, such cases are rare. Moreover, many sudden fatalities attributed to heart disease are, as a matter of fact, due to other causes, such as apoplexy; but the dramatic quality of such deaths as do occur from obscure heart diseases has caused an exaggerated impression in the popular mind of their prevalence.

Usually, however, the attack of angina pectoris is not fatal and soon passes. But the pain is subject to repetitions, either frequently or at long intervals, and while sudden death is possible at any time it is often deferred for years.

A carefully regulated life does much to reduce the frequency of attacks, and there are certain drugs which may prevent an attack, if taken when it threatens.

Somewhat similar to angina pectoris are seizures of breathlessness or of difficult breathing without pain. These are known as *cardiac asthma* or *angina sine dolore*. Their treatment is the same as that of angina pectoris.

Much more frequent than either of these is the pain referable to the heart in nervous people, known as *pseudo* or *false angina*. This has nothing to do with true angina pectoris or with any organic disease of the heart, and is wholly without danger.

IRREGULARITIES OF HEART ACTION

There are various irregularities of heart action or abnormalities of rate. Some of these have no unfavorable effect; others are more or less inconsistent with full efficiency of the heart.

Very common, especially in children and young people, is slowing or speeding up of the heart's action in relation to breathing. This is an effect, not of any abnormality of the heart, but only of influences from the nervous system modifying the heart rate. It is entirely harmless.

Heart rhythm which is interrupted by doubled or skipped beats known as *extra systoles* is frequent. Apparently, it is due to irritability of the heart muscle at some localized point, but is too insignificant to be classed as a disease. This form of irregularity is best disregarded, except in those who have organic heart disease recognizable by other evidence.

Complete irregularity of the heart, without any underlying regular rhythm, is known as *auricular fibrillation.* In this disorder the auricles, which in the normal heartbeat regularly furnish the signal for each contraction of the ventricle, fail to work rhythmically, but instead are in sort of quivering paralysis. From this abnormal state of the auricles the ventricles receive irregular impulses to contract, instead of normal, regular ones. The resulting heart action is wholly disorderly, having no trace of any regularity of rhythm. Auricular fibrillation is most frequently present as an accompaniment of organic heart disease, and then it is to be regarded as an additional handicap to an already impaired heart. In the less numerous cases in which it is present without other evidence of heart disease, it is still to be considered as a rather serious abnormality. When once established it usually continues permanently, but certain drug treatments have a beneficial effect.

Alternation of the heart is a rare condition in which the rhythm is normal, but every second beat is weaker than the beat preceding it. It usually occurs in states of exhaustion which are already ominous. It is to be differentiated from the much commoner "bigeminal pulse," in which the beats occur regularly in pairs with a pause between each pair—a rather frequent result of extra systoles, not to be taken seriously.

Heart-block is a rare disorder resulting in abnormally slow heart action. Its cause, from which its name is derived, is a break or blocking in the path of conduction by which contractions of the auricles transmit impulses for the ventricles to contract. Thus, although the auricles contract normally, the ventricles assume a slow, regular rate of their own, without relation to the auricular contractions, usually about forty beats to the minute. Such conductivity disorder may be due to various causes. The path of conduction is composed of a narrow band of differentiated muscle fibers leading from the auricles to the ventricles, known as the *auriculo-ventricular band* or the bundle of His. This band may be paralyzed without organic injury by overdosage with certain heart stimulants. It may lose its function for a while as a result of temporary inflammations; like that in rheumatic fever. It may be cut off permanently by syphilis, by tumors, or by degeneration resulting from arteriosclerosis. In patients with heart-block the efficiency of the heart is below normal, so that there is usually shortness of breath. In addition, heart-block is the basis of the combination of symptoms known as *Stokes-Adams disease,* in which there are also fainting attacks or convulsions from time to time, resulting from momentary cessation of the heartbeats. This condition is one in which sudden death is to be feared.

Paroxysmal tachycardia is a curious and rather frequent misbehavior of the heart, in which its action abruptly jumps to twice the normal rate, and then, after seconds, minutes, or hours goes with similar suddenness to the normal rate. Some persons are unconscious of these changes; others have uncomfortable palpitation aggravated by apprehension in connection with them. These attacks seem to have the same origin as extrasystoles, the mechanism apparently being that each extrasystole causes another in a self-sustaining sequence, continuing until in some way the sequence is broken. Most people who have paroxysmal tachycardia are not particularly handicapped by it. If, however, the attacks involve discomfort and are frequent, a doctor should be consulted, since there are certain treatments which tend to prevent them.

NEUROCIRCULATORY ASTHENIA AND NERVOUS PALPITATION

During the late war many soldiers were found to be incapable of active exertion because of pain in the region of the heart which developed on marching with their packs or on hurrying during drills. Occasionally in civil life the same symptoms are encountered in persons who for any reason exert themselves more than seems to be natural to them, especially under conditions of excitement. It is probable that the palpitations and discomforts referred to the region of the heart by nervous people are of the same nature, and if there is persistent exertion despite these symptoms, the pain or distress becomes incapacitating. Nevertheless, there is no evidence in these cases that the heart is organically diseased. One theory having some weight is that improper breathing by failure to use the diaphragm normally, or perhaps even muscular cramp of the diaphragm, may be the primary difficulty, such deficient breathing acting as a handicap to an otherwise normal heart.

In most cases in civil practice such symptoms are accepted as reason for avoiding strenuous physical work. They should not, however, cause worry, since they do not seem to have any unfavorable effect other than to produce temporary discomfort during unusual activity. They have no effect on the duration of life, and if taken calmly they tend to diminish or disappear. A few cases have been greatly benefited or apparently cured by training in breathing exercises. Tea, coffee, and tobacco are distinctly unfavorable.

PERICARDITIS

The heart, as elsewhere described, hangs free in a cavity which is lined by a smooth slippery membrane known as the pericardium. Like the pleura and the lining membranes of joints, this sometimes becomes inflamed. Such an inflammation may manifest itself variously. It may be a simple and temporary one; it may result in the outpouring of watery fluid (serum) which presses upon the heart; it may form pus, in which case there is serious febrile disease; it may, in healing, form scarlike adhesions, or the joining of apposing surfaces, which limit free action of the heart.

Simple or Dry Pericarditis.—This is usually a complication of rheumatic fever, although it may occur in the course of other diseases. It causes a variable amount of pain in the chest, and a physician recognizes the condition by hearing, when he listens with the stethoscope, a scratching or rubbing sound as the heart beats. In most instances the pain is of only a few days' duration and there are no unfavorable after-effects.

Pericarditis with Effusion.—This disease is analogous to pleurisy with effusion, in that, after beginning as dry pericarditis, the more severe cases result in outpouring of watery fluid. The production of this fluid is undoubtedly nature's method of separating and lubricating the inflamed surfaces, and as the fluid appears the pain ceases. But nature sometimes supplies this fluid too liberally, with the result that the pericardial space becomes so filled that pressure within it interferes with the flow of blood into the heart between beats. This may cause extreme breathlessness, and is not without danger. In the more serious instances the excess of fluid may be withdrawn through a hollow needle by a process known as *aspiration.*

Suppurative or Purulent Pericarditis.—This is a disease analogous to empyema. Rheumatic pericarditis does not tend to pus formation, but pericarditis in pneumonia and in some other acute infections may cause pus to gather within the pericardial cavity. The result is always a very grave condition requiring surgical drainage.

Adhesive Pericarditis.—Adhesive pericarditis is the possible after-effect of any inflammation of the pericardium. The inflamed surfaces grow together, and the result is a thick leathery sheath instead of a soft, pliable one. While it is unusual for pericarditis to be followed by adhesions sufficient to do harm, there are occasional instances in which the heart is so incased in fibrous adhesions as to handicap it permanently, causing symptoms more or less similar to those in chronic valvular disease.

ARTERIOSCLEROSIS

The changes that take place in the arteries which constitute arteriosclerosis have been previously discussed.[4] When arteriosclerosis reaches its advanced stages it may cause various diseases, notably *chronic interstitial nephritis,*[5] *myocarditis* and *angina pectoris,*[6] the mental disorders of old age, and *apoplexy.*[7] These are described elsewhere. Many old people, however, have arteriosclerosis without harmful effects.

Much thought has been devoted, both within and without the medical profession, to the problem of checking arteriosclerosis. Unfortunately, however, practically no progress has been made. It is generally believed that living at a fast pace accelerates its development, and that a calm relaxed mode of life favors longevity. Overeating, especially of meat, is perhaps unfavorable, but aside from such regulation of habits there is no treatment of appreciable effect.

ANEURYSM

The great artery which conveys the blood from the left ventricle of the heart is called the *aorta.* It has an ascending, a transverse, and a descending portion. The transverse portion is called the arch of the aorta, and is situated between the upper portion of the breastbone and the spine. This arch, which forms the proximal portion of the aorta, is frequently subject to weakness of its walls as a result of disease, particularly of syphilis. This weakening sometimes causes a breaking or stretching of some layers of its structure, so that a bulge is formed in the course of the artery. Such a condition resulting from dilatation of the walls of any artery is called an *aneurysm,* and may be compared with an automobile tire about to burst.

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[4] See section on Degenerations in chapter entitled Pathology, or Tissue Changes in Injury or Disease, p. 138.

[5] See section on Interstitial Nephritis in chapter entitled Diseases of the Kidneys and Urinary System, p. 341.

[6] See section on Disease of Heart Muscle and Angina Pectoris and Cardiac Asthma, in this chapter, pp. 277-278.

[7] See section on Diseases of the Brain in chapter entitled Diseases of the Nervous System, p. 354.

Aneurysm of the arch of the aorta is a disease of middle or later life. Its symptoms are not always the same, as the exact position of the aneurysm is variable, but they are chiefly the results of pressure upon surrounding structures. Usually there is pain; there may be cough and difficulty in breathing; frequently, there is weakness of the voice from paralysis of a nerve which extends from this region to the larynx. There may be difficulty in swallowing. Aneurysms of the descending aorta, or of the junction of its transverse and descending portions, often cause pain referable to the back. There is danger that sooner or later the aneurysm will burst, causing sudden death from hemorrhage; but in many cases an aneurysm, clearly discernible by the X-ray, may be kept under control for years if the mode of living is carefully regulated.

CHAPTER XXVI

DISEASES OF THE BLOOD

As explained elsewhere, the blood is a circulating fluid containing microscopic solid corpuscles. Its chief function is to carry oxygen from the lungs to the various tissues where it is needed. This function is performed by the so-called red corpuscles, of which in health there are five million per cubic millimeter, each containing a certain amount of colored substance called hemoglobin which has the special property of absorbing and giving off oxygen according to its surroundings.

ANÆMIA

When the amount of hemoglobin in the blood is less than normal the condition is called anæmia. It is of two varieties. In the milder type of anæmia the number of red corpuscles remains normal but each corpuscle contains less than a normal supply of hemoglobin. In the more severe variety, the number of corpuscles is less than normal and each of these may or may not have the normal amount of hemoglobin.

The symptoms of anæmia are due to the deficient amount of hemoglobin. The color of the skin, and still more, that of the mucous membranes such as the lips, is paler than normal because of the pallor of the blood within them. The patient is subject to breathlessness on exertion, much as in heart disease, because the circulating blood is not capable of carrying enough oxygen and carbon dioxide. There may be faintness, muscular weakness, and general symptoms of debility.

In most instances, anæmia is merely an expression of one or more of the various underlying abnormal conditions which may cause a deficiency of hemoglobin. Anæmia invariably results whenever a large amount of blood has been lost. Such loss may be either continuous, as in hemorrhage, or oft repeated, as in frequent nosebleeds, bleeding piles, or excessive menstruation. The anæmic condition of the blood exists until a new supply of hemoglobin can be developed. Other causes of anæmia are intestinal parasites, notably the hookworm of our southern states; chronic lead poisoning, which may produce marked symptoms; and certain acute or chronic diseases, such as the pus-forming infections, typhoid fever, and malaria among the former, and cancer and nephritis among the latter. If anæmia exists when no definite disease is apparent, the cause may be generally ascribed to poor diet and faulty hygiene.

Chlorosis.—Young women are particularly subject to anæmia, usually of a mild grade but sometimes quite pronounced, the cause of which is not clear. This type of anæmia, called *chlorosis,* was extremely common a generation ago, but for some unknown reason is now relatively rare. Disappearance of the fashion of tight lacing has been suggested as a cause for the improvement, but this explanation has no secure foundation.

Pernicious Anœmia.—The most serious form of anæmia is one in which there is not only a loss of blood or destruction of red corpuscles, but also inadequate regeneration of blood corpuscles by the bone-marrow. Microscopic examination of the blood shows the number of red corpuscles to be far below normal, and such as are present are of irregular size and distorted shape. At autopsy, examination of the bones shows that the marrow is changed from its normal yellowish, fatty appearance to a blood-red color, and its microscopic structure is also markedly abnormal. The underlying cause is not known.

Pernicious anæmia is a disease usually of middle life marked by the development of symptoms of anæmia, often accompanied by a tendency to diarrhea or other intestinal indigestion, but usually without the loss of weight so common in other chronic diseases. The pallor may be extreme and have a yellowish tinge. The degree of debility and the outcome of the disease are proportionate to the lowering of the hemoglobin; the patient may be bedridden and death may ensue. However, the natural course of the disease is subject to spontaneous improvements in the blood; there are repeated attacks of pallor and weakness with intervening remissions, even for months, in which the blood and general condition are almost or quite normal. Thus, in any attack there is always hope that temporary recuperation may take place, although complete recovery from the disease is not to be expected.

In the treatment of pernicious anæmia and also of severe forms of other types of anæmia, there are two resources of modern medicine which are of great value: (1) *blood transfusion,* which is used as a means of securing temporary improvement when the condition is one of immediate danger; and (2) *a diet rich in liver* which is useful in aiding improvement of the condition of the blood.

Transfusion in connection with anæmia denotes the process by which blood is transferred from the circulation of a healthy individual into that of a patient. This procedure has been in use for many years, but recently its technic has been much improved. To transfuse blood with safety, certain facts in relation to the properties of the blood must be known, and these are only ascertainable by laboratory analyses; in this way the physician is enabled to find an individual whose blood is suited to that of a given patient. Under these circumstances the benefit to the patient is usually immediate and pronounced; and, if certain other precautions are observed in regard to the amount of blood withdrawn, the procedure is usually rendered harmless to the donor.

Very recently it has been well established that patients with pernicious and other forms of anæmia, who have not improved under ordinary management, are greatly benefited by a diet containing liberal amounts of liver, together with an abundance of fruits and fresh vegetables and a relative reduction in fats. Such a diet would seem to furnish the requisites for the generation of blood. The substance by virtue of which liver exerts its favorable action has been extracted in concentrated form as a powder.

Drugs have a certain value in the treatment of anæmia. Hemoglobin is an iron-containing substance, and the administration of iron is of value particularly when the red corpuscles are deficient in hemoglobin. In chlorosis, iron is of decided benefit. If used with extreme care, arsenic in minute doses is beneficial in many blood diseases, especially in pernicious anæmia; its action seems to be to render the red corpuscles less liable to destruction. There are other drugs, and likewise some nonmedical measures, such as massage and hydrotherapy, which may be used in anæmia with beneficial effects.

ERYTHEMIA OR POLYCYTHEMIA

A rare abnormality exists which is the opposite of anæmia, that is, a condition in which there are too many red corpuscles in the blood. This disease is so infrequent that discussion, save for the mention of its existence, is beyond the purposes of this book.

LEUKOCYTOSIS AND LEUKÆMIA

The white corpuscles of the blood as well as the red show abnormalities in disease. In most fevers, particularly those involving inflammation of tissues, the white corpuscles are increased in number. Such a temporary increase is called *leukocytosis*. It is not a disease but a symptom, probably representing a natural defense reaction.

Very different from this, however, are the permanent and progressive increases of various forms of white corpuscles, associated with enlargement of lymph glands or of the spleen, which occur in the chronic disease known as *leukœmia*. The increase in white cells in leukæmia is apparently of the same nature as the growth of cellular tissue which forms the malignant tumors, carcinoma, or sarcoma. The significance of leukæmia is similar to that of any malignant tumor which cannot be removed surgically; its course is slowly progressive and incurable. However, much may be done to retard its progress by the use of X-ray and radium.

LYMPHOMA OR HODGKIN'S DISEASE

Somewhat similar to leukæmia is a disease known as *lymphoma* or *Hodgkin's disease,* which manifests itself by a pronounced enlargement of lymph glands in various parts of the body, but without the blood changes of leukæmia. This disease is classed among the conditions allied to malignant tumors. Its course is progressive, except that it frequently improves temporarily with the use of X-ray and radium.

SPLENIC ANÆMIA OR BANTI'S DISEASE

This is a rare condition in which there is anæmia accompanied by pronounced enlargement of the spleen. In the more advanced stages the liver is also involved, with results resembling those of cirrhosis of the liver.[1] In cases recognized before this change in the liver has occurred, surgical removal of the spleen is curative. Otherwise the disease is progressive.

PURPURA

In many diseases there is a failure of the normal defenses against bleeding, so that nosebleed, bleeding from the stomach and intestine, and from the kidneys readily takes place and may be persistent. There is also a tendency to bleeding into the skin and other tissues of the body, resulting in purplish spots and rashes similar in appearance to bruises. This tendency to bleeding sometimes occurs in fevers, and is the basis of the terms "black smallpox" and "black measles";

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[1] See section on Cirrhosis of the Liver in chapter entitled Diseases and Disorders of the Digestive System, p. 325.

it is also seen in meningitis. While in these diseases it is of serious significance, slight *purpura* is present in certain mild disorders of little importance.

Differing from such purpura symptomatic of other disease, the condition may occasionally exist independently, as the chief manifestation of an abnormal condition. Severe bleeding from many parts of the body is known as *purpura hemorrhagica.* This disease apparently results from a deficiency of certain minute bodies which play a necessary part in the coagulation of blood. These are known as *blood-platelets,* and in dangerous instances increase in their supply by transfusion of blood from a normal person is ordinarily effective in controlling the bleeding. When, in spite of this, bleeding recurs persistently, surgical removal of the spleen is indicated.

HEMOPHILIA ("BLEEDERS")

Certain individuals, almost exclusively males, have the characteristic of bleeding with abnormal profusion from any slight wound. Such persons are known as "bleeders." The peculiarity seems to be inherited, occurring in successive generations. Transfusion overcomes temporary bleeding, but throughout life, care to avoid wounds and injuries is necessary.

CHAPTER XXVII

DISEASES OF THE LUNGS AND RESPIRATORY TRACT

Diseases of the upper air passages, the nose, the throat, and the larynx, including hay fever, sinusitis, and laryngitis, constitute a specialty in medicine and are therefore considered separately in another chapter. Pneumonia and tuberculosis have been described.[1]

BRONCHITIS

As previously described,[2] the bronchial tubes or bronchi are branches of the trachea or windpipe forming a structure resembling an inverted tree. *Bronchitis* is an inflammation of these tubes and occurs in different forms depending upon the type of inflammation and upon the particular branches involved. The disease may be acute or chronic.

Acute Bronchitis.—Simple catarrhal colds may chiefly involve the trachea and large bronchi, as they more frequently do the larynx or the nose. In all three, the pathological process is the same. The mucous membrane becomes pinkish and sensitive, and secretes an increased amount of watery discharge. Acute bronchitis begins with the slight fever and general symptoms of other colds, together with cough and expectoration of watery or glairy sputum, which is nature's protective lubricant to the inflamed mucous membrane. Within a few days the irritation producing the cough becomes less intense, the sputum becomes "looser," and in the course of a week or two the condition subsides. The extent to which the inflammation descends into the finer tubes is variable, generally proportionate to the severity of the attack. If these participate in the inflammation there are bubbling or squeaking sounds, called *râles,* as the air enters the lungs, and there may be conscious difficulty in breathing.

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[1] See sections on Pneumonia and Tuberculosis in chapter entitled Infections, pp. 216, 226.

[2] See section on The Lungs in chapter entitled The Lungs and Respiratory System, p. 61.

The chief measure in the treatment of acute or severe bronchitis is protection from exposure, since its mismanagement by permitting activity and exposure may readily be followed by pneumonia. The disease demands relaxation and suspension of daily routine, with confinement indoors or even in bed, according to its severity. If given opportunity, the natural recuperative forces will effect a cure; but certain drugs are useful to lessen the irritation and to increase the sputum. These are administered internally, by inhalations or injections.

Chronic Bronchitis.—If an acute bronchitis fails to subside it may result in long-continued cough, especially throughout the winter season. In many cases this is the result of neglect or mismanagement by the patient who has permitted the inflammation to persist (1) by coughing with unnecessary violence and frequency, thus continuing the irritation; (2) by breathing cold, dusty air through the mouth instead of through the nose; and (3) by using the voice. Many coughs would subside more promptly if precautions were observed in regard to these three factors. In some instances nasal obstruction, as by adenoids, has much to do with continuance of the cough by necessitating mouth breathing.

In older people chronic bronchitis has another significance since, in a large proportion of cases, it seems to have its foundation in their less efficient heart action. The source of the difficulty in these individuals is probably due to overactivity which causes a congestion in the circulation of the lungs thus favoring the persistence of infection. In such cases, rest is the influence most likely to effect improvement.

Among the medical profession the term chronic bronchitis is used only after thorough investigation to exclude tuberculosis. A cough which does not subside within a few weeks should be regarded by the layman as reason for physical examination to determine its significance.

ASTHMA

True asthma, properly known as *bronchial asthma,* is often confused with other conditions to which the term "asthma" is applied with less precision. As is elsewhere described, many people, particularly those in middle life, assume that their difficulty in breathing is asthmatic, when the condition is really a disorder of the heart. Bronchial asthma is a disturbance related to hay fever; it seems to be a reaction of susceptible persons to some protein substance to which they are sensitive because of an individual peculiarity. In those cases traceable by careful study, it is often the inhalation of some material such as pollens, horse dander, or flour dust that produces the attack. In a few instances foods are responsible. In other individuals, bacterial infections of the respiratory tract or of other parts of the body produce within the body the substance which causes asthma. Although it is impossible to find the actual cause of the disorder in a certain proportion of cases, the symptoms are nevertheless similar to those in which the cause can be determined. The asthmatic reaction is one that involves temporary narrowing of the finer air passages, causing difficulty in breathing; in contrast with simple breathlessness from other causes, there is more difficulty in forcing the air out of the lungs than in drawing it in. Why sensitiveness to such foreign substances should in certain persons result in asthma, while in others it causes hay fever, and in still others it produces hives, is to be explained only on grounds of individual peculiarity.

Bronchial asthma ordinarily begins in childhood or in youth. The symptoms occur intermittently, probably depending upon factors that favor exposure to the causative substance. Cases due to pollens are seasonal, like hay fever. Those caused by bacterial infections have symptoms which increase during the activity of such infections. In some of the cases in childhood the disease is subsequently outgrown. In extreme cases, asthma proves to be a handicap persisting throughout life. However, it may be partially controlled. To those who have not become accustomed to their occurrence, the asthmatic attacks are terrifying as well as distressing, because of the sense of threatened suffocation. The alarm, however, is unwarranted, as the attack subsides sooner or later even without treatment. Asthma is a source of distress rather than a danger to life; it often occasions loss of sleep, and particularly impairs economic and general efficiency. Persons with asthma also have a somewhat increased predisposition to pneumonia.

The treatment of asthma may be various. The most satisfactory results are obtained if the particular cause of the attacks in a given case is determined and measures adopted to prevent their occurrence. As in hay fever, which is due to pollens and other dusts, much may be accomplished by guarding the patient from exposure to these; and, in a certain proportion of cases, the patient's sensitiveness to this cause may be diminished by the development of an immunity through systematic injections of minute amounts of this substance. In those cases which are traced to bacterial infections, some may be relieved by treatment of the local infection, and others improved by immunization against the bacteria. Such modes of attacking the disease are of comparatively recent development. While in many instances a great deal has been accomplished, there are many other cases in which appreciable improvement has not been possible by these methods.

For reasons not entirely understood the treatment of abnormal conditions in the nasal cavities often effects improvement in some cases of asthma.

Certain drugs are of value in diminishing asthmatic attacks, but patients react variously to them. Therefore, in asthma not otherwise controlled, the older method of trying one prescription after another until a remedy is found which exerts a beneficial effect in the particular case, is still employed.

In the asthmatic attacks, a very effectual measure for temporary relief is injection through the skin of a substance derived from the adrenal glands of animals. Certain medicines taken by mouth, as well as the fumes of certain powders which are burned in the room, are of assistance.

The present situation in regard to asthma is a tantalizing one; some understanding of the disorder has been attained but this is still so limited that only partial control of the disease has been effected.

EMPHYSEMA OF THE LUNGS

Emphysema is a pathological process in which the lungs gradually undergo a change that renders the walls of the air cells thin or wasted so that they function less efficiently. The condition is observed most frequently in persons who have long been subject to cough or to asthma, although it may occur in others without known cause. The result is breathlessness which may be so extreme as to prevent even slight exertion. Its symptoms and management are much the same as in chronic heart disease.[3]

HEMORRHAGE OR BLEEDING FROM THE THROAT OR LUNGS

Whenever any blood is raised in coughing a physician should be consulted, since in many cases it is the first symptom of tuberculosis. If large amounts of blood are expectorated, it usually creates more alarm than the actual danger warrants, as bleeding from the lungs, not preceded by other serious symptoms, is rarely fatal. Such a condition has slighter medical significance *per se* than it has as a warning of the possible presence of tuberculosis. If by this means tuberculosis is recognized while it is still curable, this symptom may be regarded as a fortunate occurrence.

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[3] See section on Diseases of Heart Valves in chapter entitled Diseases of the Heart and Circulation, p. 271.

When bleeding from the lungs occurs, the patient should be put to bed and there propped in a sitting posture; coughing should be suppressed as much as possible and talking forbidden. The physician will probably utilize additional measures to control the cough and so arrest the bleeding; in the great majority of cases it will stop within a day or two, except in advanced tuberculosis already known to be hopeless.

ABSCESS AND GANGRENE OF THE LUNGS

These are rare conditions, consisting respectively of abscess formation within the lung tissue, and destruction of certain areas of lung tissue. Both may be caused, either by infection which is carried to the lungs from another part of the body through the circulation, or by the inhalation of foreign bodies or other substances. In each of these conditions the sputum is profuse and its odor offensive. General supportive measures, as in tuberculosis, are indicated. A posture with the head downward during the act of coughing should be assumed every hour or two, so that gravity may aid expectoration. Surgical measures are sometimes applicable in individual cases in which the involvement in the lungs is accessible.

PLEURISY

Pleurisy, or pleuritis, is an inflammation of the pleura or surface membrane of the lung. In most cases of pneumonia there is also pleuritis, but when pleurisy is mentioned separately it is commonly understood to denote an inflammation of the pleura without pneumonia. Usually this inflammation is non-suppurative.[4]

Two forms of pleurisy are described; (1) dry pleurisy, and

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[4] Many cases of pleurisy are due to infection of the pleura by the tubercle bacillus, and it is possible that most pleurisy is in reality a tuberculous process. On the other hand, tuberculous pleurisy should not be confused with pulmonary tuberculosis. Tuberculous pleurisy tends to recover after a fairly definite course of less than two months, and in about two-thirds of the cases it does not affect subsequent life. In the remainder, the pleurisy is accompanied or followed by tuberculosis of the lungs.

(2) pleurisy with effusion. More accurately they are two stages of the same process.

Dry pleurisy represents the first stage of inflammation of some part of the pleural surface. Its characteristic symptom is a painful stitch in the side occurring with each breath, the result of movement of the lung within the chest. There may be a little fever, but usually pain is the only symptom. Examination with the stethoscope often reveals abnormal breath sounds resembling that heard when two leathery surfaces are rubbed over each other. For some days after the onset the pain is severe, but diminishes progressively, either subsiding within a week or persisting much longer in a mild form, perhaps with recurrencies.

In a certain proportion of cases, probably those in which the inflammation is more intense, the inflamed membranes secrete a clear, watery fluid similar to that which collects in a blister of the skin. This constitutes *serofibrinous* pleurisy or pleurisy with effusion. When this fluid appears the pain ceases; it is undoubtedly nature's measure to lubricate and separate painful inflamed surfaces. But in cases of pleurisy severe enough to produce fluid, there is usually distinct fever of two to four weeks' duration, and the patient recognizes that he is ill. Two or even three quarts of this fluid may accumulate in the space between the lung and the chest wall, the lung being compressed in proportion to its amount. When this occurs there is breathlessness on the slightest exertion. Various methods are used to determine the presence of such an accumulation of fluid. The usual one is percussion, or thumping upon the affected side of the chest; if fluid is present the normal hollow sound is not obtained. In some cases so much fluid collects in the chest that it seriously interferes with breathing. Rarely fluid secretes about both lungs (double pleurisy) and there is actual danger of suffocation. If more fluid is present than it is safe to leave for spontaneous absorption the excess may be withdrawn by the slight operation of tapping, that is, inserting a hollow needle between two ribs and applying siphonage.

In most cases of pleurisy with effusion the fever gradually subsides, the fluid usually disappearing in three to six weeks.

Either form of pleurisy requires a careful régime and medical supervision during and after the convalescence, since satistics show that one out of every three cases develops pulmonary tuberculosis.

EMPYEMA

In contrast with ordinary pleurisy, empyema is a suppurative or pus-forming inflammation of the pleura. This is the most frequent complication of pneumonia, and the condition is rare save as such complication. In most instances it develops after a pneumonia has run its course and so represents a relapse in the general condition, interrupting the convalescence. It results in continued fever and wasting, but the shortness of breath so conspicuous during the active stage of the pneumonia is ordinarily absent.

Unlike the watery fluid of simple pleurisy, pus accumulations cannot be absorbed spontaneously, nor are they curable by simple tapping. Continuous drainage must be provided by one of several surgical methods, so that all of the pus may find a ready outlet until at last it gradually ceases to form. Without such drainage, fever and wasting continue and finally prove fatal.

PNEUMOTHORAX

In rare instances, air escapes or leaks from the lung into the pleural cavity, causing the lung to collapse like a punctured balloon. In many cases the escape of air from the lung is due to pulmonary tuberculosis. There is sudden pain in the chest and alarming breathlessness. Usually these symptoms of onset gradually subside and the patient becomes comfortable while at rest, but breathlessness develops upon any exertion.

In most cases the opening in the lung closes spontaneously, the air being absorbed in the course of the following weeks. Ordinarily, immediate treatment consists of rest in bed and utilization of measures to ease the discomfort. In convalescence it becomes necessary to determine the presence of tuberculosis of the lung and to deal with the situation accordingly.

CHAPTER XXVIII

DISEASES AND DISORDERS OF THE DIGESTIVE SYSTEM

DYSPEPSIAS WITHOUT STRUCTURAL DISEASE

Completely normal digestion by the stomach takes place wholly without sensation. It is sometimes said of a man with good digestion that "he does not know where his stomach is." Neverthless, since it is the rule rather than the exception, it cannot be considered abnormal to have a certain sense of fullness or pressure after a heavy meal and a little belching of air to relieve this. It is more characteristic of robust people than of invalids occasionally to indulge in meals which tax their digestive capacity to the limit and produce some slight feelings of distress.

On the other hand, many people have discomforts of various kinds in connection with digestion, either occasionally or more or less constantly. It is reasonable to suppose that, in each case, these discomforts are dependent upon some abnormality of the physiological processes of digestion, yet it is a fact well established by medical investigations that in most instances the disorder does not represent actual or organic disease, but rather what might be designated as a misbehavior of the stomach.

Many cases are readily traceable to faulty habits of eating, and gradually improve as these are corrected. Hurried eating, imperfect mastication, overeating, too frequent eating, irregular eating, poor cooking, an excess of highly seasoned foods and drinks, and alcoholic stimulants are frequently responsible either separately or in combination.

The stomach is profoundly influenced by the state of the

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nervous system. Profound emotions,[1] such as intense excitement, fear or anger, and also fatigue are unfavorable to appetite and to digestion. Calm contentment and pleasant surroundings during and after a meal are favorable.

Abnormal conditions of the body as a whole influence the stomach. Fever, pain, general weakness, pregnancy, and many diseases of organs other than the stomach affect its action. This is particularly true of diseases of the abdomen, notably of the gall bladder. Therefore, there are many possible underlying factors which may be the indirect cause of poor digestion.

Various types of digestive complaints exist; these will be mentioned separately.

Poor appetite is most frequently a symptom of nervous or other exhaustion, of states of unrest, or sometimes of almost any physical disease.

"Gas in the stomach" or a sense of pressure is not the result of gas-forming fermentation, but rather a manifestation of irritability or disturbed muscular action of the stomach. This may be due to an irritation within the stomach or to some factor apart from the stomach which disorders the functions of the digestive tract.

"Heartburn," or a burning sensation referable to the stomach, is sometimes associated with excess of acid gastric juice, or with irritation of the stomach by alcohol or by drugs. This sensation seems to originate in the esophagus more than in the stomach.

Nausea and vomiting result from three causes: (1) from intracranial disorder which causes dizziness or headache; (2) when, for any reason the stomach finds itself unable successfully to perform its function of digestion; or (3) from irritation of the stomach by its contents. In the last variety the patient usually has a conscious impulse to induce vomiting.

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[1] Observation by X-ray of the digestions of animals shows that in excitement all movements of the digestive tract cease, reappearing as the animal becomes calm. A curious illustration is furnished by African elephant hunters. When elephants are approached unawares, loud gurgling sounds from their digestive tracts are audible at some distance, but if these sounds cease it is a sign that the animals have become alarmed.

All of these symptoms may be due to obvious and easily remediable causes, or they may be inexplicable and obstinately persistent. In many cases of lifelong dyspepsia, even a complete anatomical examination after death has failed to reveal the cause.

The treatment of all these conditions is regulation of diet and habits of living, and such other measures as are indicated in the particular case.

It may be mentioned that experimenting with the stomach, and the continuous or intermittent use of various dyspepsia remedies are practices which frequently render the ultimate condition worse.

DISEASES OF THE STOMACH

It is probable that the stomach is sometimes involved in catarrhal inflammations analogous to colds in the head. Very possibly many brief attacks of vomiting are to be explained in this way, but there is no certain knowledge in the matter. As compared with colds in the head, acute disorders of the stomach are much less frequent.

More definite are the states of inflammation of the stomach due to chemical causes. These vary from the mild effects of slightly irritating foods, drinks, and drugs to the extreme and destructive results of caustic poisons.

Mild irritants taken repeatedly, of which alcohol and certain drugs are the chief examples, may cause persistent conditions of irritation or inflammation. In most of such disorders the stomach has a strong tendency to spontaneous cure, if it is left free to do so. Vomiting usually occurs when any internal irritant must be thrown off. After this, complete rest of the stomach, by ingesting nothing until it feels distinctly better and appetite appears, is usually effectual in establishing the return of normal conditions. Treatment based upon these conservative principles is highly preferable to attempts at modifying nature's methods, and in the presence of vomiting it is unwise to try complicated foods and drugs at random. Under such conditions, it is not unusual for friends and neighbors to recommend various measures which ultimately are ordinarily harmful, so that an important part of the physician's service is the prevention of mismanagement and consequent aggravation of the disorder.

Ulcer of the Stomach or Duodenum.—The most frequent serious disease of the stomach is the formation of an ulcer or open sore on its inner surface which is obstinately resistant to healing. The cause of this condition is unknown, or at least is so much disputed that it is unprofitable here to discuss the various theories. In well-marked cases, the symptoms and diagnostic signs are quite characteristic, and the ulcers, as revealed by surgery or as studied anatomically, are well-defined structural abnormalities.

These usually occur near the pylorus or outlet of the stomach, or within a few inches of it, either in the stomach or in the part of the duodenom just beyond the stomach. The ulcerative area, usually about the size of a small coin, has lost its mucous membrane and the underlying tissues have been corroded to a greater or less depth. Like the intestinal ulcers of typhoid fever, they sometimes cause bleeding, and occasionally perforate the wall of the stomach causing peritonitis.

The chief symptom is pain, which bears a constant time relationship to eating. If the ulcer is within the stomach the pain appears earlier, perhaps half an hour or less after food is taken. In ulcer of the duodenum pain does not occur until several hours after a meal, or when it is almost time for the next meal. Ulcers of the stomach, more than those of the duodenum, are likely to be accompanied by other dyspeptic symptoms similar to those of less serious disorders, and this fact renders diagnosis difficult in doubtful instances. Vomiting of blood or blood in the stools may occur at some time in a certain proportion of cases; in the latter, the blood may have changed color and so escape recognition.

The symptoms of ulcer of the stomach or of the duodenum usually develop gradually and continue indefinitely. Sometimes they are intermittent, being present in periods of a month or two, alternating with periods of freedom. In other cases they are continuous except as controlled by treatment.

In diagnosis, X-ray examinations are of distinct assistance. Usually, the ulcer itself is not visible, but when an ulcer is present the pylorus usually acts in a peculiar way which is ordinarily reflected in a series of X-ray pictures.

By way of treatment, the usual course to be followed in the more severe cases is, briefly, rest in bed for a number of weeks; small, frequent feedings according to standardized diet schedules; and sufficient use of alkalies to diminish acidity of the gastric juice. Subsequently, the diet may be gradually increased, but care in eating must be exercised indefinitely.

In the milder cases, the convalescent treatment of severe cases may be sufficient, but strict adherence for an indefinite period should be the rule.

In the more intractable cases in which medical measures are of little avail, surgery is indicated, and usually leads to improvement. An ulcer cannot be removed as is an appendix without resorting to a rather dangerous operation. The usual surgical procedure is the formation of a new opening from the stomach into the intestine beyond the duodenum, since it has been found that this is generally followed by subsidence of the symptoms. Thus surgery, in this condition, does not remove the disease but only creates anatomical changes which favor its subsidence.

Surgery is indicated in these disorders only when previous conservative measures have failed. In most instances, comparative comfort and efficiency can be maintained without surgical intervention if the patient will faithfully adhere to medical treatment.

Cancer of the Stomach.—Cancer of the stomach usually occurs in older people, rarely developing before the age of forty, and is most commonly seen in those distinctly beyond their prime. Its early symptoms are vague, but ordinarily the first complaint is the development of indigestion in those who previously have not been subject to digestive disorders. Unless loss of teeth, or some other frequent cause of indigestion in older people is present to account for the symptoms, such a history is suspicious and requires investigation.

In some other cases there is no digestive disturbance but a gradual loss of weight, resulting in weakness and usually accompanied by increasing pallor. In the later stages the peculiar pallor with evident emaciation often leads a physician to suspect cancer of the stomach even before an examination has been made.

When the disease is sufficiently advanced, a hard lump in the upper part of the abdomen is usually palpable.

Aside from digestive discomfort, actual pain in the early stages is exceptional, and even in the later stages pain is usually not so outstanding a symptom as is the increasing weakness.

Cancer of the stomach is rarely curable, even by surgery. Generally its course is progressive and death ensues, usually within a year after the diagnosis is established. In some incipient cases surgical treatment may prolong life, and in those in which obstruction of the pylorus is one of the early effects of the tumor, an operation is sometimes followed by striking temporary improvement, although the chance of a permanent cure is remote. The chief object of medical treatment is to lessen the discomfort, and in this direction much may be done by judicious management.

As compared with other diseases that cause death, cancer in any form is an unfortunate one but does not necessarily involve extreme suffering. Its terminal stages are frequently distressing, sometimes from pain, but more often from the extreme weakness incidental to the emaciation. Fortunately, when this distressing stage of incapacity is reached the end follows sooner and more mercifully than in some other more lingering diseases.

Obstruction of the Pylorus.—This is a rare condition, usually the result either of scar formation from an ulcer or of a cancer at the pylorus. Since ingested food cannot pass through to the intestine as freely as it should, it accumulates in the stomach and is discharged by vomiting, sometimes of very large amounts. Food eaten a day or more previously may be vomited. There is a gradual approach to starvation with accompanying great loss of weight.

In describing this condition to the layman it is necessary to emphasize the fact that it is quite different from ordinary indigestion in which a sense of discomfort may lead to the impression that digestive processes are delayed. Pyloric obstruction is very rare. Besides, it is possible to establish its presence with certainty by means of specially devised tests, so that apprehensive individuals may always ascertain the nature of their complaint.

Medical treatment is ineffectual; moreover, it is dangerous to delay surgery since the general condition of the patient may suddenly become unfavorable. Prompt surgical interference is conspicuously successful in relieving the obstruction, and, save in cases due to cancer, is curative. It is usually impossible to determine positively whether the obstruction is due to cancer or only to the scar of an ulcer except at the operation.

INTESTINAL DISORDERS

The functions of the long tubular structure known as the intestine are complicated, but they are normally performed with complete regularity. The wavelike, muscular action of the intestinal walls goes on constantly though we have no cognizance of it. At habitual intervals, usually once a day, there is an impulse to discharge waste and defecation is accomplished, perhaps with the passage of a small amount of gas; at other times the intestinal mechanism is wholly out of mind.

Nevertheless, it is subject to derangements even in the absence of actual disease, which are expressed chiefly by three symptoms: (1) *flatulence,* (2) *diarrhea,* and (3) *constipation.*

Flatulence.—If unaccompanied by other symptoms, flatulence usually indicates that intestinal function is disturbed, but only to a relatively mild degree.[2] Normally, the intestine contains gases distributed throughout its coils and, on listening to the abdomen with a stethoscope, gurgling sounds may be constantly heard from the movement of these gases. Under certain circumstances, however, they may form and accumulate in an excessive amount. The abdomen becomes larger, while the gurgling sounds grow louder and may be accompanied by more or less discomfort or even pain. Much gas is passed from the rectum.

Unlike the air of the stomach, intestinal gases are produced by fermentation or putrefaction of the intestinal contents, so that when gases are formed in excess they are to be attributed to overactivity of processes of decomposition. It is to be noted that these occur most actively in the lower parts of the intestinal tract, and are concerned chiefly with food substances which have escaped absorption in its upper parts. Therefore, when an excessive amount of unabsorbed food reaches the lower part of the bowels, flatulence is likely to occur.

As a matter of fact, insufficient mastication of food is the commonest cause of flatulence, undivided masses not being adapted to digestion and absorption in the upper parts of the intestinal tract. Overeating, with its consequent strain of the powers of digestion and absorption, is another frequent cause. Flatulence also results from an excess of cellulose, as contained in lettuce, celery, onions, beans, and other leafy or woody vegetables, and in fruits. Large quantities of meat or eggs in the diet may cause flatulence with peculiarly foul gases, but this is less frequent.

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[2] In certain diseases, such as typhoid fever, peritonitis, and pneumonia, flatulence may be a serious matter. In these, however, the condition is different, a disorder of the muscular coatings of the intestine being largely responsible.

Diarrhea.—Diarrhea is properly interpreted as a protective reaction by which the intestine expels contents which it cannot tolerate; vomiting performs a similar rôle for the stomach. Thus diarrhea may occur as the result of improper eating, or of cathartic drugs or poisons, or of inflammation of the intestine which renders it intolerant of any contents.

The majority of ordinary brief attacks of diarrhea are probably due to some decomposed food, or to food in some way unadapted to the individual. In mild cases the effect is no different from that of a dose of any ordinary laxative drug; there are a few large loose movements and soon the trouble ceases. In other instances, a state of irritation seems to exist which remains for a while, and this irritation may continue because of improper management. Sometimes food similar to that which caused the symptoms is repeatedly taken; or food digestible under normal conditions proves irritating to the sensitive intestine, so that the disorder is increased by eating. Occasionally, for these or other unknown reasons, a diarrhea does not cease within a few days of simple treatment, but continues indefinitely. However, no alteration of tissue occurs in any of the cases, tractable or obstinate, that warrants the classification of simple diarrhea as an organic disease. It is merely a disturbance of intestinal function, with perhaps a little catarrhal inflammation.

The general plan of treatment in the earlier cases consists of a laxative to remove abnormal contents from the intestine; a smooth, bland, light diet; and, after the laxative has acted but not before, the use of some astringent or sedative if necessary.

Cases of chronic diarrhea are sometimes very resistant to treatment. Some are ultimately found to be due to an underlying disease in another part of the body; others are dependent upon a disorder of the stomach which permits the food to reach the intestine before it has undergone normal preparation for intestinal digestion.

Constipation.—This is the abnormal state of intestinal function in which waste is discharged less frequently or with more difficulty than is considered normal. One evacuation a day is the usual normal standard, and it is certainly more satisfactory to have a daily movement habitually. On the other hand, many persons sometimes fail to have any movement for more than twenty-four hours.

In healthy individuals, regular action of the bowels requires and indicates two things. First, the function of the digestive tract as a whole must progress normally throughout the day and night to urge the semisolid residue to the lower end of the intestinal canal. Secondly, a spontaneous, conscious, motor impulse must occur each day to accomplish an evacuation. Habit is a large factor in the occurrence of this daily impulse; if the habit of a daily movement at a certain hour is once formed and is permitted to continue, it gradually becomes fixed. Most constipation probably has its origin in suppressing the natural tendency to regularity until it can be regained only with difficulty. If the natural inclination is ignored, as is frequently the case for lack of time in the day's schedule, it not only ceases to be habitual but gradually disappears.

Another similar factor may have some bearing upon the prevalence of constipation among civilized peoples. This is the suppression, for reasons of delicacy, of natural impulses to discharge intestinal gases. If such gases are retained by voluntary effort the end of the intestinal passage becomes stretched and ineffectual in the act of evacuation.

But these causes seem to be responsible only in those cases in which the difficulty lies in the discharge of material which has normally accumulated near the end of the intestinal canal.

There is another form of constipation in which the difficulties are of a different nature, involving failure to propel the waste material normally toward the outlet. In constipation of this type the fault seems to lie in the muscular action of the intestine which should be continuous. These cases are also of two kinds; those in which there is a general sluggishness or weakness of intestinal action, and those in which the functions of the different parts of the intestinal tract fail to coördinate. Disorders of secretion and of absorption resulting in an abnormal dryness of the intestinal contents may likewise play a part. In such departures from normal function the underlying factors are frequently obscure, and their results are often obstinate and difficult to correct.

On the other hand, there is much exaggeration in the popular mind as to the medical significance of constipation. It is true that this condition tends to some extent to produce headaches, loss of appetite, abdominal discomfort, and a certain general lessening of the sense of well-being. It very probably is an unfavorable factor in certain disorders such as chronic arthritis, asthma, and some skin diseases. But fear that failure to evacuate will involve danger is not justified. Such a condition may exist even for a number of days without dire result. Constipation and the grave condition elsewhere described as *intestinal obstruction* are rarely related. Constipation, even if left entirely untreated, will generally relieve itself spontaneously. In the absence of other symptoms of serious illness there is no cause for alarm, or for the too ready resort to violent cathartics. In fact, constipation is chiefly objectionable because of the tendency of apprehensive individuals to attach undue importance to the condition and so meddle with it unwisely.

Mucous Colitis.—This is a somewhat rare and rather obscure disorder in which large amounts of mucus are discharged into the intestine from time to time, usually with more or less pain. It occurs almost exclusively in persons of nervous temperament, and the attacks are frequently precipitated by conditions which act upon the nervous system, rather than by those ordinarily responsible for intestinal indigestion. Of the latter, however, constipation is a factor as it may sometimes be followed by paroxysms of excessive mucous discharge.

The disorder is often obstinate, but careful diet combined with attention to the nervous equilibrium improves most cases, and in many instances the attacks become less numerous or cease entirely.

PTOSIS OR DROPPING OF ABDOMINAL ORGANS

Persons with postural defects, that is, rounded shoulders, protruding abdomen, and hollow chest tend to take on an altered appearance with altered positions of internal organs. The stomach, the transverse portion of the large intestine, and the kidneys sag downward. This results from continued failure of the abdominal muscles properly to support the contents of the abdomen. Weakness of the walls of the abdomen after childbirth is frequently a contributory factor. Such sagging of organs may be detected on physical examination, and has been increasingly revealed since the development of the X-ray. A great deal of undesirable attention has been directed to these displacements. While so-called falling of the stomach or of the kidney may produce some symptoms, most of them are usually due to the general debility which has caused the habitual incorrect posture. Moreover, much harm is done when a person so affected is told that an organ is displaced, since the existence of a real abnormality appeals to the imagination and tends to fix the idea of invalidism.

In the majority of cases, the best treatment is training in improved posture and in more wholesome physical and mental habits.

INTESTINAL OBSTRUCTION

In rare cases the intestinal tract becomes kinked or otherwise closed, with the result that a violent condition of illness occurs which is fatal unless the obstruction is relieved by surgery. Such stoppage does not occur as a result of ordinary constipation, but rather from various more or less accidental abnormalities which pinch, twist, or kink the intestine. When such an obstruction takes place there is severe pain and continued vomiting, and, before long, the odor of intestinal contents is present in the vomitus. Usually, the abdomen becomes distended. The condition is a surgical emergency, since nothing save surgery will relieve it; moreover, the danger is greatly increased if operation is delayed.

Chronic Intestinal Obstruction.—There are cases, most commonly the result of cancer of the large intestine or rectum, which cause intermittent or partial intestinal obstruction, with alternating periods of distention and pain followed by loose movements usually containing blood. Their treatment is likewise surgical. In some cases the cause of the obstruction is removable and in others in which it is not, an artificial opening may be made above the obstruction, which will prolong life, frequently without discomfort or much inconvenience.

APPENDICITIS

Half a century ago, a much dreaded condition had long been known by the various terms, peritonitis, inflammation of the bowels, iliac phlegmon, coeliac passion, or perityphlitis. It was recognized that the disorder was an inflammation beginning in the region of the cecum and extending to the peritoneal cavity. But the first conclusive proof that the vermiform appendix was the structure in which the inflammation originated was offered in 1886 by Dr. Reginald H. Fitz of Boston. And since a knowledge of the prevention of bacterial infection in surgery had already made operations upon the abdomen possible, it was soon demonstrated by many surgeons that removal of an inflamed appendix before the inflammation had spread to the peritoneum would prevent the peritonitis, which up to that time had led to fatal results in a large proportion of cases. Since then the operation has been perfected, until now its performance involves less risk than any other major operation, provided it is undertaken sufficiently early. But its diagnosis, or the recognition that one patient has appendicitis and another a pain for which the appendix is not responsible, has not yet been thoroughly perfected.

As mentioned,[3] the vermiform appendix is a small worm-shaped appendage of no apparent use attached to or springing from the cecum or beginning of the large intestine, low in the right side of the abdomen. For reasons still not understood, this small organ sometimes becomes inflamed, and pus collects within it until its walls become stretched and weakened. Thus, the appendix becomes an inflamed sac of pus within the abdomen.

At this stage, surgical removal of the appendix eliminates the entire disease. But if no operation is performed the appendix will burst, and will allow the pus containing bacteria of infection to flow into the peritoneal cavity among the loose coils of the intestine. If this occurs the result is peritonitis [4] either local, forming an abscess, or general, involving the entire peritoneal cavity.

There is one point which the layman should thoroughly understand. If, at the time when an inflamed appendix bursts, the intestine is abnormally active as the result of taking castor oil or other cathartic, the peritonitis which ensues is bound to be more widespread and serious. *Therefore, when any possibility of appendicitis exists, all cathartics should be avoided.*

As a rule the symptoms of appendicitis begin either suddenly, or become fully developed within a few hours. The first and most significant symptom is pain, usually not of extreme severity but acute enough for an individual to recognize the presence of something more than any ordinary abdominal pain. Somewhat misleadingly, the pain often seems to be high in the abdomen, instead of low down on the right side where the appendix is actually located. In a considerable proportion of cases the onset of the pain is followed by vomiting, but this is usually not so violent or so frequently repeated as that in acute disorders of the stomach. Soon fever develops, but this is rarely high save in children, and may be so slight as to seem unimportant.

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[3] See section on The Intestine in chapter entitled The Digestive System: Foods, Digestion, and Absorption, p. 81.

[4] See section on Peritonitis in chapter entitled Diseases and Disorders of the Digestive System, p. 318.

The signs upon which a physician bases his diagnosis are obtained by palpating the abdomen. Tenderness on pressure over the region of the appendix is usually present, but other important findings are elicited during examination by a trained sense of touch. An increase in the number of white corpuscles in the blood is usually present in appendicitis, as it is in most other active inflammations, and this is of some service in differentiating appendicitis from non-inflammatory causes of abdominal pain. In mild cases the inflammation may still subside, but in all severe instances the walls of the appendix rupture, discharging the pus and the bacteria which caused it into the abdomen.

When, after a variable number of hours, an inflamed appendix bursts it soon becomes evident that the condition is more serious. The pain becomes more widespread and intense, and the muscles of the abdominal wall tend to become rigidly contracted. If operation is further delayed the remaining course is that of peritonitis or of abdominal abscess.

That the treatment of acute appendicitis should always be prompt surgery is so much a part of common knowledge that it scarcely bears repetition. But there is an aspect of treatment deserving of all possible emphasis, since its truth is not sufficiently known. Our American people have a deeply rooted habit of taking cathartics at random for abdominal pains, and there is reason to suspect that this has been the real cause of a large proportion of deaths in appendicitis. In Europe this disorder is sometimes called "The American Disease." If appendicitis is suspected, cathartics or laxatives should be avoided; the patient should fast completely and remain in bed, propped in a sitting posture, until medical attention can be obtained.

Another train of events has sometimes led to disaster. Many patients have demanded morphine at once for their pain, and then, when the physician has given it against his better judgment, the relief has been so pronounced that operation has not been permitted. Doctors at times have been criticized for their seeming cruelty in refusing to administer opiates in suspected appendicitis; but it is a generally accepted principle among the medical profession, that a definite risk is entailed if symptoms are obscured by morphine before the diagnosis has been established and consent obtained to operate. The opinionated patient who refuses the advice of the physician is particularly in danger with reference to appendicitis.

It must, however, be admitted that up to the present time the methods for establishing diagnosis in appendicitis have not been perfected. Most cases are evident to any physician, and those with special experience are sure of a larger proportion; but there are instances in which definite diagnosis is impossible. For this reason there have been uncertainties and even errors, and since successful treatment in appendicitis is dependent upon correct diagnosis, the practical management of doubtful cases is and must yet remain imperfect. No individual physician is responsible for this situation; it is due to our present inadequate information.

This fact should be understood and appreciated by the laity as well as by the medical profession. At best the situation is unsatisfactory; but the basis for decision in a given case should be the ultimate safety and recovery of the patient. If, after consideration of all available evidence, there is equally divided uncertainty between an appendix in danger of rupturing and a condition which will subside without operation, the chances should be estimated. In such cases recovery by operation occurs in all but about one-half of one per cent, although there is always a possibility that the operation will be found to have been unnecessary. On the other hand, if operation is deferred either until the appendix ruptures or until a condition which is not appendicitis subsides, the danger of death is increased to about ten per cent, but, of course, there is always a chance that surgery may be escaped. Obviously, operation offers the safer course; it should be performed as a matter of insurance. "I do not dare not to operate" is an expression used by one of the best authorities on appendicitis in commenting upon such cases, the implication being that surgery involves only a negligible risk, while delay is fraught with danger.

The person who advises against operation for the treatment of appendicitis assumes a grave responsibility. The disease is a treacherous one. The natural impulse to be conservative in the presence of uncertainty is, in effect, a pitfall, and the situation is rendered more difficult by the patient's natural aversion to surgical intervention and his failure to understand that prompt surgery is the safer course. If this fact were more generally recognized by the laity, some of the disastrous results in appendicitis could be avoided.

But, as in all things, there are limits. When the real cause of the pain is intestinal indigestion, appendicitis being only a minor possibility, the surgeon may still be tempted to avoid possible dangers of delay by operating. Of course, the majority of such patients will be found not to have appendicitis. As is sometimes suspected, but for the most part unjustly, the expectation of a large fee might conceivably influence the decision.[5] Clearly, however, it is not reasonable to operate upon every case of abdominal pain of which the nature is not at once evident. In any case, reliance must be placed on the judgment of the attending physician or of the consultant. At best, there must be a certain small percentage of operations which could with more perfect knowledge have been avoided; and, unless surgery is resorted to habitually, there must be occasional instances in which operation has been disastrously delayed. Such errors are inevitable at the present time. Progress in medicine has done much to reduce the mortality from appendicitis, but unfortunately the situation has not yet attained perfection.

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[5] Within the author's knowledge the accusation of operating because of financial considerations has no foundation in fact among surgeons of good professional standing and repute. On the other hand, there is reason to suspect that quackery, both unorganized and organized, in the form of advertising surgical institutes, may be invading the field of surgery. Protection of the public lies chiefly in knowing the personal character and reputation of their physicians and consulting surgeons.

PERITONITIS

As indicated in several references already made to the subject, inflammation of the peritoneum is one of the most serious of the inflammations which may take place. The reason for this is the great extent of the area over which the inflammation may extend, the entire abdominal cavity becoming, for practical purposes, an enormous abscess or a collection of many abscesses.

With rare exceptions, infection of the peritoneum is the result of some less grave disease in the abdomen which permits material containing bacteria to escape into the peritoneum. Appendicitis is the most frequent of these, and may be compared to a boil which discharges its pus into the peritoneal cavity instead of upon the surface of the body. Perforating ulcers, such as ulcers of the stomach or the intestinal ulcers of typhoid fever, may break through, so that contents of the stomach or the intestine may escape, and thus produce peritonitis. Wounds of the abdomen and blows which burst the stomach or intestine are similar in their results. Infections of the gall bladder may extend to the peritoneum. In all of these diseases, peritonitis is the complication most to be dreaded.

The onset of peritonitis from any of these causes is marked by intense pain, usually accompanied by involuntary rigid contraction of the abdominal muscles. Frequently there is vomiting, and usually inability to move the bowels. A certain amount of fever is present, but rapid pulse and prostration are the more conspicuous features. Subsequently, in unfavorable cases, the abdomen becomes greatly distended.

Peritonitis is not always an infection of the entire abdomen. If the material which carries the infection escapes gradually, the peritoneum has a natural defense mechanism to combat it. This defense consists of the formation of a sticky, gluelike substance on the infected surfaces, which seals up the infection in a small area surrounded by coils of intestine. In such cases the peritonitis is only a local manifestation or an abdominal abscess, most of the peritoneum remaining uninfected.

Surgery is the only treatment for acute peritonitis. An attempt should be made to close the source of infection and to establish channels by which pus formed in the abdomen may escape. Without surgical intervention peritonitis is almost invariably fatal. Immediate operation, however, results in the survival of many cases. The point to be emphasized in this connection is that the outcome largely depends upon the promptitude with which operation is performed. If surgery is undertaken within a few hours after the onset it is much more likely to result in recovery than if it is delayed for twelve or twenty-four hours.

Gonorrheal Peritonitis.—A special variety of peritonitis is that which is due to gonorrheal infection of the pelvic organs in women. This differs from the acute peritonitis described above in that it may result in most instances in recovery without operation.

Tuberculous Peritonitis.—A chronic form of peritonitis, wholly different from acute peritonitis, is due to infection of the peritoneum by the tubercle bacillus. This occurs most commonly in children and young adults, more frequently in women than in men. It belongs to the class of chronic inflammations not tending to pus formation, but usually resulting in the accummulation of watery fluid within the abdomen. It begins gradually with little or no pain. Its chief features are enlargement of the abdomen because of the collection of fluid, accompanied by some fever, more or less loss of weight, and weakness. In certain cases there is no enlargement of the abdomen but only a disturbance of intestinal function.

By way of treatment, surgery may be attempted for the relief of tuberculous peritonitis, but its ultimate value in favoring recovery has been disputed. However, whether or not surgery is undertaken, the general mode of living prescribed for other forms of tuberculosis is of great importance. Discomfort from distention of the abdomen may be relieved by withdrawing the fluid through a hollow needle, a minor operative procedure.

In a young child tuberculous peritonitis is extremely serious. In older children and adults tuberculous infection of the peritoneum is not so grave a condition, tending to recovery in the majority of instances.

ASCITES OR "DROPSY OF THE ABDOMEN"

In a number of different diseases, and by various mechanisms, watery fluid may ooze from the organs and tissues of the abdomen into the spaces of the peritoneum so as to fill and distend the abdominal cavity. The result is visible enlargement of the abdomen which may be quite marked and which differs from the distention due to flatulence in that it is accompanied by a sense of weight in the abdomen.

Chronic heart disease, kidney disease, cirrhosis of the liver, tuberculous peritonitis, and certain tumors of the abdominal and pelvic regions are the chief causes.

By way of treatment, temporary relief may be afforded by withdrawing the fluid through a hollow needle. Apart from this the treatment is that of the disorder which is the underlying cause, as described elsewhere in the sections dealing with those diseases.

GALLSTONES AND INFLAMMATION OF THE GALL BLADDER

It was said [6] that the gall bladder is a pouch which lies attached to the under surface of the liver, beneath the lower border of the ribs on the right side. It is a side-chamber or sac leading off from the duct or tube which carries the bile from the liver to the duodenum, and it serves the unessential purpose of storing a certain amount of bile. The fact that it is unnecessary is well proved, since, in many individuals in whom the gall bladder has been completely removed because of disease, life continues perfectly well without it. The gall bladder is about the size of a hen's egg, but is considerably longer and narrower and is pointed at its posterior end where it connects with the bile duct.

The gall bladder is peculiarly subject to inflammation. Rarely, this is an acute pus-forming condition analogous to appendicitis, save that its rupture occurs much less readily. Far more frequently, however, inflammation of the gall bladder is mild and chronic, often causing no recognizable symptoms. The commonest effect of such a mildly inflamed gall bladder is to cause, in the course of years, the formation of gravel-like or pebble-like bodies within it, known as *gallstones.*

These are usual abnormal developments within the human body; it has been estimated that they are present in two to ten per cent of all persons. They occur chiefly during or after middle life, and are several times more frequent in women than in men. Pregnancy and typhoid fever favor their formation in subsequent years. Sedentary habits are a causative factor since the condition is found more commonly in stout persons than in thin ones.

In many cases, however, the existence of gallstones causes no symptoms, and from first to last exerts no unfavorable effect.

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[6] See section on Diseases Involving Inflammation in chapter entitled Pathology, or Tissue Changes in Injury or Disease, p. 132.

In persons who have gallstones which cause trouble, the chief symptom is severe pain occurring in attacks known as *gallstone colic.* These attacks result when the gallstone moves from its resting place in the gall bladder and assumes a position by which the outlet of this organ is obstructed. The effect is intense pain, usually in the upper right side of the abdomen, but sometimes seeming to the patient to originate in different places, that is, in the back, left side, or even in one shoulder. Vomiting may or may not be present. Usually, the pain is so acute as to require an opiate and, with few exceptions, when the patient awakens after the effect of this has passed the pain is gone. In those who have had attacks of gallstone colic without the administration of opiates the cessation of the pain has occurred rather suddenly after having continued from a few minutes to twelve hours. With few exceptions the obstruction relieves itself spontaneously.

Occasionally the stone passes from the gall bladder into the main bile duct, and when this happens there is obstruction of the flow of bile from the liver to the intestine, which results in jaundice. Usually, the stone that causes this is a small one and soon passes into the intestine, so that the jaundice is only slight and temporary. Sometimes an occasional stone is found in waste passed from the intestine. In rare and serious instances, on the other hand, a gallstone becomes lodged in the main bile duct, obstructing it permanently and causing continuous jaundice which may be relieved only by surgery.

While the most typical effect of gallstones is to cause these irregular attacks of severe colic, there are other cases without intense pain in which obstinate symptoms of indigestion or dyspepsia are present.

The only effectual treatment for gallstones or pronounced disease of the gall bladder is the removal of the stones, and usually of the gall bladder. Many nostrums to dissolve gallstones have been extensively advertised but none are efficacious. In some cases of less pronounced disease of the gall bladder, where there are similar symptoms without stones, medicines which tend to make the bile more liquid are sometimes given; but gallstones are removable only by surgery. On the other hand, in deciding upon the necessity of operation, it is not enough merely to determine the presence of gallstones or disease of the gall bladder; in addition it must be established that they are the cause of symptoms of which the patient complains. For many people who have gallstones have no ill effects from them, and even if the stones are demonstrable by X-ray, as is sometimes the case, they may still be causing no harm. But where gallstones are the cause of symptoms their removal gives complete relief.

The diagnosis of gallstones, like that of appendicitis, is difficult and is subject at best to a certain degree of error. Unfortunately, these stones are composed of organic material which is dense enough to cause shadows in the X-ray only in exceptional instances. Moreover, as it is ordinarily impossible to feel the gall bladder or stones within it on physical examination, the diagnosis of gall bladder disease or gallstones depends largely upon the patient's description of his symptoms, and his general appearance and behavior during the attack, all of which are unfortunately subject to misinterpretation. Therefore in these conditions, as is sometimes the case in appendicitis, the patient's hope of relief may lie in an operative procedure undertaken in the belief that it may be the proper method of attack, without waiting for absolute proof. If the patient's condition is intolerable, and gallstones are considered the probable cause, surgery offers much, and with relatively little risk if the diagnosis is found to be incorrect; but refusal of operation while any doubt exists can only result in a continuation of suffering. In cases of gall bladder disease, however, the decision as to surgical intervention does not have to be made instantly as in appendicitis; but, as in cases of appendicitis, it is dependent upon a careful study of the evidence by the physician to determine what course is wisest for the patient in a situation involving some elements of uncertainty.

JAUNDICE

A common disorder both in children and adults is the so-called *catarrhal jaundice*, which is never a serious disease. In rarer cases, chiefly in older adults, there are other conditions with jaundice resulting from several underlying serious diseases. Jaundice, properly speaking, is only a symptom indicating that the bile formed in the liver is not being normally discharged into the intestine and in consequence is becoming absorbed by the blood and carried to the tissues of all parts of the body. Thus the skin and the whites of the eyes assume a yellow tinge, and the urine becomes more yellow than normal, or even brown. Conversely, if no bile enters the intestine the material discharged from it is grayish, without the normal yellowish or brown color derived from bile. In the ordinary jaundice it is probably a catarrhal inflammation of the bile ducts that prevents the bile from flowing through them. This in turn is probably a sequel to a catarrhal inflammation of the stomach and duodenum, similar to a cold. Vomiting may be present in the early stages of illness, soon after which the yellow skin and eyes and dark urine are noticed. The bowels are usually constipated.

After the onset there is little discomfort, except that there may be itching of the skin and not infrequently a peculiar tendency to a depressed mental attitude [7] which may continue for some weeks. After a week or ten days, sometimes longer, the normal color of the movements reappears, and the jaundice gradually fades.

Gallstones, cirrhosis of the liver, and tumors in the region of the bile ducts are usually attended by jaundice at some time in their course.

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[7] The word *melancholy* is derived from the Greek words *melan* (black) and *chol* (bile) indicating that, since ancient times, depression of spirits has been regarded as related to disorders of the liver.

CIRRHOSIS OF THE LIVER

Alcohol, taken habitually for long periods in concentrated form, sometimes results in a disease of the entire liver, causing first an enlargement of the organ and later a contraction and hardening from fibrous degeneration. There are other conditions in which the liver undergoes similar changes, beginning gradually but ending in serious impairment. When such changes in the liver have become sufficiently advanced, there is interference with the circulation of the blood through the liver, causing a distention of the veins within the abdomen and an oozing from these veins of watery fluid. Many quarts of this fluid may accumulate and great distention of the abdomen follows. Cirrhosis in any form, except where syphilis is a factor, is incurable, leading to increasing malnutrition, gradual loss of strength, and frequently to mental changes. Repeated "tappings" to withdraw the fluid are necessary.

PANCREATITIS

Acute pancreatitis is a rare inflammation of the pancreas. It is a disease of extreme severity, requiring immediate surgical intervention, and the outcome is always doubtful.

Chronic pancreatitis is a degenerative change resulting in loss of power to digest and to absorb fats.

Diabetes [8] is the result of a degeneration or loss of function of the structures in the pancreas which form the ferment that controls the conversion of blood-sugar.

Cysts of the pancreas are sacs of fluid of unknown origin which in rare cases cause swelling of the upper part of the abdomen, accompanied by more or less pain. They may be removed, if necessary.

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[8] See section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

CHAPTER XXIX

DISEASES OF METABOLISM AND OF DISORDERED INTERNAL SECRETIONS

THE THYROID GLAND

At the present time there is comparatively little definite knowledge concerning the internal secretions and their disorders, this branch of medicine being still in its infancy; but of all the organs concerned in these processes, the thyroid is best understood. This gland, consisting of two islands, one on either side of the Adam's apple, joined by a narrow isthmus across the middle of the throat, is absolutely essential to life. Its function is the production and internal secretion of a substance containing iodine which is known as *thyroxin* and is very vital to the body. The removal or destruction of the thyroid results in a pathological condition called *myxedema;* overactivity of the gland likewise causes the disease known as *exophthalmic goiter.*

Myxedema.—In certain infants, known as *cretins,* there is deficiency of thyroid secretion from birth. Symptoms of thyroid insufficiency may also occur in adults, sometimes without known cause, and at times as a result of faulty surgical technic, that is, when too much of the gland has been removed at operation.

Myxedema produces complicated but characteristic abnormalities of the body and of the mind, of which perhaps the most conspicuous are: (1) Coarsening and puffiness of the features and of the entire body with increase in body weight; (2) dryness and coarseness of the skin and hair; (3) a sluggishness of all physical and mental processes. In cretinism, underdevelopment and deficient mentality are likewise present.

Within recent years a test has been devised by means of which the activity of fundamental body processes may be measured, and in myxedema it gives an index to the degree of abnormality. This test is known as the basal metabolic rate.

Thyroid deficiency may be supplemented very effectually by preparations made from the thyroid glands of animals. These may be taken by mouth and are readily absorbed by the tissues, and by carefully regulated dosage many cretins and persons incapacitated by myxedema have become practically normal, the defective function of the gland being overcome to a degree. It is to be understood, however, that thyroid preparations are merely substitutes for what should be produced naturally within the body, and must be taken continuously to prevent the return of abnormal conditions. It is also to be emphasized that overdosage with thyroid is possible, so that its administration should be carefully supervised by a physician.

Simple Goiter.—Any enlargement of the thyroid gland is called a goiter. In certain localities, notably in Switzerland, a large proportion of the native population have swellings of this gland, sometimes of considerable size. There is a similar but less marked prevalence of goiter in various parts of this country. In recent years it has been conclusively demonstrated that such abnormal development of the thyroid gland results from a lack of iodine in the drinking water and diet of those who live in these regions; and it has also been shown that if iodides are administered to these individuals for short periods twice a year the development of goiter will be prevented. Except for disfigurement and inconvenience, simple goiter is ordinarily without symptoms; but in certain instances there is pressure upon the trachea causing cough or difficulty in breathing. If such mechanical effects become intolerable, part of the goiter may be removed by surgical operation.

Exophthalmic Goiter.—A remarkable and not very uncommon disease is that known as exophthalmic goiter in which there is enlargement or overactivity of the thyroid gland combined with resultant increased activity in the physical and mental processes. In this condition there is also a tendency to a peculiar prominence of the eyeballs. Palpitation and rapid heartbeat are noticeable, and there is apt to be loss of weight in spite of a liberal diet. Nervousness is pronounced; even the appearance of the patient suggests a constant state of alarm. The onset is sometimes rather sudden, although it may be gradual. The course continues for one or more years. While in most cases a spontaneous improvement and recovery will eventually occur, the delay, particularly in severe cases, is fraught with danger. It is therefore usually advisable to remove part of the thyroid gland, a procedure from which marked benefit may be expected.

Toxic Goiter.—This form of goiter, sometimes called *hyperthyroidism,* is a less pronounced and slightly different disorder. While the prominence of the eyes does not occur and the general symptoms are less marked, the disturbance of heart action, the malnutrition, and the nervousness may be grave. This condition may exist in all grades of severity from actual invalidism to what may be regarded as only a peculiarity of the individual. Temporary disturbances which simulate hyperthyroidism are frequently seen in those who have taken thyroid preparations promiscuously and without medical supervision for the purpose of reducing weight.

The severity of the disorder conditions the treatment of all diseases in which there is overactivity of the thyroid gland. It may be medical or surgical. When there is pronounced ill health and incapacity to continue occupation, surgical treatment offers the best prospect. The operation, however, is one which requires a high degree of skill and experience. Where surgery is not employed, treatment is confined to regulation of the mode of living supplemented by certain drugs by means of which the disease will usually remain quiescent or subside.

ADDISON'S DISEASE

In rare instances the adrenal or suprarenal glands are the seat of a tuberculous inflammation which results in their progressive destruction. The outcome is a condition of peculiar weakness, associated with very low blood pressure. For unknown reasons there is a brownish discoloration of the skin. The course of the disease is progressive through months or years, and treatment with adrenal preparations from animal sources has not been successful.

TETANY

Tetany is a disorder marked by a tendency to convulsive movements, especially of the hands, which occurs more commonly in children than in adults and particularly in those with rickets.[1] A deficiency of calcium in the circulating blood is one of the symptoms, and this abnormality seems to be connected with the *parathyroid glands,* which are small organs of internal secretion situated in the neck on either side of the thyroid. In the treatment of this condition extracts from the parathyroid glands of animals are of considerable benefit.

DISORDERS CONNECTED WITH THE PITUITARY GLAND

Lying beneath the undersurface of the brain there is a small and somewhat mysterious glandular organ which has a profound influence upon the growth of the body. Deficient activity of this gland seems to result variously in underdevelopment or dwarfism, or in other cases in a peculiar lack of development of the sexual characteristics at puberty, combined with obesity. *Gigantism,* seen in circus side shows, and also the condition known as *acromegaly* in which there is abnormal development of the facial bones and of the hands and feet, seem to result from overactivity of the pituitary gland. Administration of pituitary substances by mouth have given no conclusive results.

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[1] See section on Rickets in chapter entitled Infancy and Its Disorders, p. 428.

DIABETES

Diabetes is one of the serious diseases of frequent occurrence and there is evidence that it is increasing. It is a disorder of metabolism in which the body cannot fully utilize the carbohydrate intake.

Contrary to popular belief, it is not a disease of the kidneys, although urinary abnormalities are among its chief symptoms, that is, an increase in amount, and the appearance of glucose in the urine. It is a condition in which the glucose or dextrose of the blood cannot perform the next chemical step necessary to meet the particular needs of the body. This has been described in a previous chapter.[2] Instead of proceeding through the changes by which it should utimately be oxidized into carbon dioxide and water, evolving heat and mechanical power in the process, this blood-sugar merely accumulates in the blood in excessive proportion, and is thrown off in the urine, since one of the normal functions of the kidneys is to remove excess sugar from the blood whenever it is present.

This inability of the body to utilize sugar seems to be due to a failure of the pancreas to produce the substance necessary to convert sugar into its next derivatives, notably into the glycogen of the muscles. It is assumed that the pancreas contributes normally to the body a product which may be compared with that supplied by yeast to sugar-containing grape juice in fermentation—a substance[3] that transforms sugar into something else. The next change of blood-sugar is generally understood not to be a conversion into alcohol, as in alcoholic fermentation outside of the body; but, whatever the result is, it seems to require a ferment-like substance to induce it. This substance is normally derived from the pancreas.

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[2] See section on Absorption of Food Substances in chapter entitled The Digestive System: Foods, Digestion, and Absorption, p. 86.

[3] Such little-understood substances that promote chemical changes, of which the pepsin of the stomach is another example, are called enzymes, or ferments.

Diabetes, therefore, is primarily a disease of the pancreas. Changes in its microscopic structure are undoubtedly responsible for this loss of capacity to produce the normal ferment. But the fundamental cause of diabetes to which these changes are due is still to be discovered.

Loss of the necessary pancreatic derivative is never complete. Victims of diabetes are still able to utilize a certain amount of blood-sugar, the amount varying with the severity of the disease. Diabetes, therefore, is a disorder in which there is partial deficiency of function of the pancreas.

It follows from this, that an important phase of the treatment of diabetes is to eat only as much sugar-forming food as can be utilized. For if larger amounts of starches and sugars are taken they will only be excreted in the urine, and their use will be accompanied by an increase of the symptoms. Moreover, all diabetic patients should understand that, if more carbohydrate is ingested than the pancreas can convert, its already impaired function will subsequently be further diminished. In other words, the diabetes will grow worse.

This necessarily decreased intake of carbohydrate food may be supplemented, except in the more severe cases, by an increase of protein, fats, and oils, as the body will otherwise consume its own fat and grow thin. But there is a limit to the amount of fat that can be utilized, since the greatest danger in cases of diabetes not controlled by careful treatment is a poisoning by products formed within the body which are derived from fats. This poisoning by fatty acids (*acidosis*) results in unconsciousness (*diabetic coma*) and frequently in death.

Diabetes is usually a disease of gradual onset and of slow course. The initial symptom may be one of several: excessive thirst is a common one; when a person habitually gets up at night to drink water one should always suspect it; increase in the amount of urine is the first abnormality some patients notice; unusual hunger is the first symptom in others. Sometimes irritation of the skin of and about the genital organs is the first complaint. Some cases in unobservant persons are discovered only in the advanced stage, long after the real onset of the disease.

The diagnosis is made by means of a chemical test which reveals glucose in the urine. The severity of the disease (meaning how much or how little carbohydrate food can be utilized) is determined by trials of various diets, and by tests of the urine and of the blood.

The treatment consists of regulation of the diet in such a manner that the blood will not contain excess of sugar, that sugar will not appear in the urine, and that the normal body weight will be maintained. This can usually be accomplished by attention to the diet alone.

A recent advance in medicine has been the discovery of a substance called insulin, obtained from the pancreas of animals, which is utilized by the body in a way similar to that of the natural pancreatic ferment. This substance is administered by hypodermic through the skin. Thus, when a person has diabetes in so severe a form that a satisfactory condition cannot be maintained by dieting alone, it is possible to eat more carbohydrate and derive benefit from it if, for each increase in the carbohydrate eaten, a sufficient amount of insulin is injected to provide for this excess of carbohydrate over the previous allowance. Two daily insulin injections are usually required. In addition, extremely careful calculation of the diet is necessary, since either too much carbohydrate or too much insulin will prove harmful. Insulin has been a great boon to many diabetics, but to gain its benefits with safety the physician's directions must be followed implicitly and without relaxation.

The treatment of diabetes, more than that of almost any other disease, requires minute attention to detail. It is highly systematized, and without exceptions, its success absolutely depends upon strict adherence to the outlined daily schedule.

GOUT

Gout, at least in this country, is a comparatively rare disease. Its popular significance is due to the fact that generations ago the disorder was more frequent than it is at present, and to the further fact that many conditions spoken of as "gouty" have, in reality, nothing to do with true gout.

The disease is only partially understood, but is known to involve an abnormal production within the body of crystalline compounds of uric acid, by a departure from the normal process of nitrogenous metabolism. The more remote causes of this are not clear. Familial tendencies are to some extent a predisposing factor, and in general gout is associated with overindulgence in food and drink combined with physical inactivity. On the other hand, many self-indulgent, sluggish people do not have gout, and in some pronounced cases of gout overeating and lack of exercise are not conspicuous among the personal habits.

The most typical manifestations of the disease are sudden attacks of joint pain, usually in the great toe, occurring at irregular intervals. In other instances there are various less typical symptoms, from indigestion to heart and kidney disturbances, in which gout seems to be the underlying factor. In pronounced cases there are visible deposits of uric acid compounds in various parts of the body, sometimes in the margins of the ears and sometimes near joints of the fingers and near the knees and elbows. But it should be understood that gout is the cause of only a very small proportion of the swellings and distortions seen in fingers and hands to which the laity habitually refer as "gouty fingers."

The treatment of gout consists of a simple diet combined with a careful, systematic, supervised increase in the general physical activity. Measures for the relief of the pains in acute gout differ materially from those employed in other joint disorders.

OBESITY

Obesity is a medical problem only in persons whose bodies tend to accumulate fat in perceptibly abnormal proportions. It is more of a cosmetic problem in those who, for the sake of appearance, desire to be thinner than nature apparently intended them to be. From the anatomical point of view it may be plausibly argued that each individual is endowed with a certain number of fat cells, which in the state natural to them should be filled out, and can be kept unfilled only by relative starvation. On the other hand, it is possible to effect considerable regulation of the total body fat by means of diet and exercise without endangering the general health. Regulation of weight within reasonable limits is desirable, but regulation of weight which necessitates unnaturally severe restrictions is inadvisable.

Magazines for women are replete with articles describing various methods of reducing weight. Many of them are fantastic, even irrational. The only reasonable measures are those having two objects: (1) lowering of the total calories in the daily diet regularly maintained for weeks or months; and (2) increase of calorie-consuming exercise and work. The innumerable systems of diets, exercises, baths, and massage serve only to accomplish these two things.

One precaution should always be taken: reduction should be effected gradually and gently. Many women have precipitated attacks of nervous prostration by extreme methods. It is imprudent to lose weight more rapidly than at the rate of three pounds a week.

Thyroid preparations have of late attained an unwholesome popularity with those who treat themselves for obesity. It is true that administration of thyroid will result in loss of weight, and that many abnormally stout individuals require it. But the use of thyroid, except in carefully regulated dosage, is prone to cause or to aggravate nervous instability. In most cases it is an unnatural influence and is best avoided, save in the few instances in which it is indicated by medical tests.

Many patent preparations sold under different names contain thyroid. Other "reducers" are pure frauds, and have no ingredient more effectual than plain water. They promise results which cannot possibly follow their use save by conformity to a diet list which accompanies them.

Of the extensively advertised mechanical devices those which apply massage serve chiefly as substitutes for exercise. Those which apply pressure may have the effect of diminishing deposits of fat in one part of the body only to increase them elsewhere.

There are certain more rigorous reducing methods which are particularly used by pugilists under the direction of their trainers, but they are unnecessary in medical practice.

DISEASES DUE TO VITAMIN DEFICIENCY

There are three diseases that do not occur under conditions of normal living but which often occur when unnaturally restricted diets are used. They are: *Scurvy, Beriberi,* and *Pellagra.*

Scurvy.—This disease figured prominently in the accounts of ancient voyages, but with the advent of the knowledge that it may be prevented by small rations of fruit juices, it has become rare. It is, however, occasionally seen, sometimes on ships, sometimes in labor camps, and sometimes even among city dwellers whose diets are limited by reason of poverty. In adults, its most conspicuous symptom is tenderness and bleeding of the gums and loosening of the teeth. There may be bleeding from other parts of the body, and purplish "black and blue" spots under the surface of the skin.

Infantile scurvy is a modern disease which has appeared coincidentally with the practice of sterilizing milk. In infants, the chief symptom is pain and tenderness at points where blood-clots form about bones. Frequently the urine is bloody. Pasteurization of milk destroys the vitamin which prevents scurvy, so that infants fed only on pasteurized, condensed, or powdered milk mixtures are ready victims.

The treatment of scurvy consists of the administration of orange or tomato juice, which are effectual even in the bottled or canned forms, as well as a change of diet with respect to an increase of all fresh foods.

Beriberi.—Beriberi is due to a deficiency in the diet of a vitamin contained in the surface layers of rice and of other cereal grains. It became prevalent in the Orient when the polishing of rice was introduced, to give it a more attractive appearance. It is frequently seen among Labrador fishermen whose diet is chiefly based upon white flour, without the varied foods that supply vitamins in other diets. The symptoms are those of a painful inflammation of peripheral nerves, with swelling of the limbs and fever. Yeast is useful in its treatment.

Pellagra.—The third of these diseases, is, broadly speaking, one which occurs in those who, after having been accustomed to a diet rich in natural fresh foods, change to one in which such foods are lacking. The condition has been common among mill workers in our southern states, who have migrated from farms where fresh milk, eggs, meats, and vegetables were plentiful to a village where only canned and preserved foods were available. Other cases have developed in prisons and institutions. The most serious result is mental derangement, which is incurable, unless the disease is treated in its early stages. The disorder is recognized by peculiar alterations in the skin.

CHAPTER XXX

DISEASES OF THE KIDNEYS AND URINARY SYSTEM

CURRENT MISCONCEPTIONS

Diseases of the kidneys have been used so intensively by quacks as a subject for fraudulent misinformation that they are the cause of much undue apprehension. In this connection attention should be directed particularly to the fact that, contrary to advertisements, pain in the back has its origin in kidney disease only in very rare instances. It is proverbial in the medical profession that when a patient complains of "pain in the kidneys," the immediate presumption is that the kidneys are in no way accountable for the symptoms.

Certain variations in the appearance of the urine are frequently interpreted as pathological by apprehensive persons who are unfortunately easily impressed by fraudulent advertisements. One of the most brazen falsehoods used in quackery is the statement that if the urine deposits a brick-dust-colored sediment when placed in the cold, it is an indication of disease. As a matter of fact, any urine permitted to stand at sufficiently low temperature will deposit such a sediment. It is composed of the urates which at body temperature remain in solution in every urine, but are less soluble in the cold. If the urine is warmed it will become clear again.

Paleness and increased amount of the urine sometimes cause worry. While in one form of kidney disease, to be described later, the urine does show these and other changes, in most instances the excretion of pale urine in increased amounts is due to conditions not to be considered abnormal. Nervous excitement tends to produce a more active formation of pale, dilute urine; drinking more than the ordinary amount of water and, particularly, the overuse of tea and coffee have this result.

A urine which is more deeply yellow than usual means merely that fluids have been taken in less than the average amount and, while it is generally advisable not to be too sparing in the use of drinking water, an overconcentrated urine is scarcely more likely than a dilute one to indicate the presence of disease. On the other hand, there are color changes of the urine which sometimes indicate abnormality: for instance, brownish color with yellow foam in jaundice; reddish or smoky-brown color suggesting the presence of blood; and various other colors are sometimes caused by drugs. Quacks sometimes dispense bland-looking pills constituted of a dye, methylene blue, which causes the urine to be blue or green, then trading upon the emotional state created by this startling phenomenon.

Turbidity or cloudiness of freshly voided urine is due to several causes, some abnormal, others not. It is usually the result of a precipitate of phosphates, which is entirely harmless and particularly occurs during active digestion of a meal, but it also occurs for some unknown reason, in connection with mental activity and physical inactivity. Medical students are especially apt to notice this. Turbidity due to the failure of phosphates to remain in solution is readily identified, since on adding a little acid of any kind to the urine it will immediately become clear, while if urates or pus are its cause adding acid will not clarify it.

Albumin is the most frequent abnormal constituent of urine. It is detectable only by chemical tests. Its significance varies and may be determined in each case. It is present in most forms of kidney disease. Very commonly, however, and particularly when found in urine during the day but not in that formed at night, it is apparently entirely harmless.

ORGANIC DISEASES OF THE KIDNEYS

Though there is much unncessary worry in connection with abnormalities of the urinary system, certain diseases of the kidneys are nevertheless characteristically insidious in their onset. An individual may be entirely unconscious of the presence of such disease and yet it may exist in a form readily detectable on examination. Therefore, there is reason for regarding kidney diseases as dangers which may come upon one unawares. They are perhaps the chief reason for periodic medical examinations, a practice which is becoming increasingly prevalent, although subject to certain abuses.

The most important disease of the kidneys is *nephritis* or *Bright's disease*, of which three or perhaps four principal types exist. There are also pus-forming inflammations of the kidney, as well as various relatively rare disorders including tumors. Stones of the kidney likewise occur.

Nephritis.—The principal varieties of nephritis are: (1) acute nephritis; (2) subacute or chronic nephritis of a type called *nephrosis;* (3) interstitial nephritis of two types, one probably a result of nephrosis, the other caused by arteriosclerosis of the kidney, both leading to a fibrous degeneration and diminution in size and efficiency of the kidneys.

Acute Nephritis.—Acute nephritis occurs most commonly a few days or weeks after scarlet fever, or after certain other acute infections. It may, however, appear when no preceding disease has been recognized. Certain poisons, notably mercury, also cause acute nephritis.

The symptoms are usually sudden and may be of varying severity. First, but often escaping notice, there is a diminution in the amount of urine excreted, and usually a change in its color to brownish or sometimes reddish because of the presence of blood. In severe cases, practically no urine is passed for a day or more. A swelling or puffiness of the face, particularly of the eyelids, is soon noticed. There may be headache, nausea, vomiting, or stupor. Frequently convulsions are the initial symptom. In rare instances there may be sudden, complete, but transitory blindness.

The urine in addition to being markedly reduced in amount, contains much albumin, and microscopic examination reveals blood-corpuscles, degenerated kidney cells, and abnormal microscopic bodies called casts.

Acute nephritis due to mercury poisoning is practically always fatal. In that produced by other causes there is usually a resumption of the secretion of urine after a few days, and a gradual subsidence of symptoms. Complete recovery is the rule, but in some instances there remains an abnormal condition of the kidneys leading to chronic disease.

The treatment of acute nephritis includes a number of measures which favor survival of the patient and resumption of kidney function. The diet is reduced to diminish the need for urinary excretion. By cathartics and by sweating, the bowels and the skin are made to throw off water which the kidneys cannot eliminate. External heat is of probable benefit to diminish congestion of the kidneys. In the presence of convulsions, unconsciousness, or other threatening symptoms, bleeding is of value. After apparent improvement has occurred, it is important to regulate the diet carefully and to avoid exposure to cold indefinitely until the urine is found to be completely normal.

Subacute or Chronic Nephritis of the Nephrosis Type.—This is usually of gradual development, being discovered in the absence of any symptoms of onset. Some instances, however, may follow an acute nephritis which has been recognized but in which treatment has failed to effect a cure. Many times the condition may be the result of a persistent local infection, particularly in the tonsils.

The initial symptoms are variable, but are apt to include swelling of the face and eyelids, headache, nausea, and breathlessness. The urine is not necessarily abnormal in appearance or in quantity, but on chemical examination is found to contain large amounts of albumin, and to be abnormal on microscopic examination. Thus, the disease is frequently discovered by urinalysis before the patient is aware of illness. If a local infection is present in the tonsils or elsewhere, its removal may succeed in arresting the nephritis. Measures of diet and elimination may afford temporary relief, but are not curative. The more favorable cases may apparently improve for a year or more, but instead of recovering, lapse into a form of interstitial nephritis. In severer instances the course is progressive and not hopeful. The extreme cases prove fatal soon after diagnosis is established.

Interstitial Nephritis.—Interstitial nephritis derives its name from the pathological process incidental to the disease; that is, the fibrous tissue in the interstices between the cells of the kidney becomes increased, while the cells upon which the function of the kidney depends degenerate and disappear to a greater or less extent. Such degeneration and disappearance of cells may result either from a preceding nephritis of the nephrosis type involving these cells, or from arteriosclerosis which results in an insufficient supply of blood to maintain their nutrition. The increase in fibrous tissue is merely the process of repair which occurs where the body cells have been destroyed. The symptoms of interstitial nephritis of either form develop gradually and are usually such as to cause suspicion of disease of the heart rather than of the kidneys. Increase in the amount of urine is the rule and that excreted during the night is usually the greater. Generally, however, the patient complains most of breathlessness on exertion, as in heart disease.

The likeness of symptomatology in diseases of the kidneys and of the heart is readily explained. As the kidneys gradually lose the cellular elements by means of which urine is secreted, the body as a whole attempts to compensate for this handicap by causing the heart to pump blood through the impaired kidneys at a faster rate, or in other words under higher pressure. Thus the blood-pressure as measured by instruments is found to be higher than normal. Naturally, to maintain increased blood-pressure the heart must work harder and, in consequence, it develops or becomes hypertrophied, just as it does in other conditions which necessitate its increased muscular action. But if the heart has to exert itself abnormally at all times to maintain an increased blood-pressure, it has less reserve to meet the exigencies of added physical exertion. Therefore, in interstitial nephritis the heart becomes unequal to the demands made upon it, and the resulting symptoms are similar to those of primary heart disease.

Interstitial nephritis has other symptoms, notably headaches, loss of strength, digestive disturbances, and gradual impairment of eyesight. In consequence of the increased blood-pressure, the patient is predisposed to cerebral hemorrhage or apoplexy.

The urine is less strikingly abnormal than it is in other types of nephritis. It is of increased amount and of low specific gravity, but there is not more than a slight trace of albumin and, in the arteriosclerotic type, frequently no albumin is present.

The treatment of interstitial nephritis, when the disease is once definitely diagnosed, is at best not thoroughly effectual. Impairment of the kidneys already exists and cannot be repaired so that the patient is permanently handicapped. Thus, treatment can be directed only toward conserving such function as yet remains. To diminish the formation of substances which the kidneys should excrete, the diet must be kept low in proteins and in salts. Elimination by the bowels is of some service. Beyond this, chief reliance in promoting the patient's welfare is to be placed in the regulation of living, exactly as in chronic heart disease.

PYELITIS AND INFECTIONS OF THE KIDNEY

Pyelitis.—This disease consists of an infection of the pelvis of the kidney and occurs rather frequently, particularly in young children and in pregnant women. As a rule only one kidney is involved. The onset is accompanied by fever and pain in the flank, usually followed in a day or two by subsidence of the pain and fever but by the appearance of pus in the urine. While in most cases spontaneous recovery takes place, there may be repeated recurrences of pain and fever extending over long periods. The essentials of treatment are rest in a horizontal position, water in large amounts, and drugs which give the urine antiseptic properties. In cases which fail to improve, certain surgical procedures are indicated to facilitate free flow of urine from the affected kidney.

Pyonephrosis.—In consequence of long-continued pyelitis, the kidney substance is sometimes largely destroyed so that only a sac of pus remains. As such a kidney is useless and is a cause of continued ill health, its removal is ordinarily advisable. One normal kidney is sufficient to sustain life.

Suppurative Nephritis.—More serious than pyelitis is infection of the kidney tissue with abscess formation. This commonly occurs in consequence of local infections in other parts of the body, the bacteria being carried to the kidney in the blood current. The symptoms are similar to those of pyelitis but usually much more severe. In cases which threaten to be fatal, surgical removal of the kidney is sometimes performed, but in all less extreme instances the treatment is similar to that of pyelitis.

Perinephritic Abscess.—Sometimes infection occurs at the surface of one kidney, producing an abscess which burrows into the muscles of the back. Such an abscess requires prompt surgical drainage, if the disease is to be readily controlled.

Tuberculosis of the Kidney.—Tuberculosis occasionally attacks the kidneys, as a rule first involving only one, the second becoming diseased at a later stage. Therefore, if the kidney first attacked is removed by surgery, the disease is sometimes eradicated. There is great difficulty, however, in diagnosing tuberculosis of the kidney, since it often fails to present characteristic symptoms. Except for loss of weight or other general evidences of ill health, there are frequently no signs until irritability of the bladder first directs attention to the urinary tract. Then by urinalysis and by internal examination of the bladder, known as *cystoscopy,* the diagnosis can usually be made, but not always before the second kidney has become involved. Persons who have had any form of tuberculosis should consult their physician immediately upon the appearance of any urinary symptoms in order that tuberculosis of the kidney may not advance unrecognized.

Stones in the Kidney and Urinary Tract.—For reasons not wholly known, although preceding infections may bear some relation to its causation, solid material resembling gravel or even large pebbles may be formed at almost any point in the urinary tract. These are composed of various crystalline substances such as uric acid, calcium phosphate, or oxalate, all of which are precipitated from the urine. The larger stones are formed by gradually increasing deposits about a small original particle which remains stationary. Stones are found especially in the pelvis of the kidney, in ureters, and in the bladder.

While in many instances stones may be present without causing symptoms, a stone often becomes dislodged from the place of its formation, moving downward along the course of the urine and frequently being passed in the urine. Such movement of a stone is usually accompanied by an attack of extreme pain, known as *renal colic,* sometimes recurring at frequent intervals. Even when stones remain stationary and do not produce pain, infection tends to occur about them so that sooner or later there is a condition of inflammation of the pelvis of the kidney or of the bladder, originally caused by the stone.

Diagnosis of the presence of urinary stones is often difficult but is aided by various special methods, particularly the X-ray which is of great assistance.

Decision in regard to removal of the stone depends upon the individual case, but the probability of subsequent infection if the stone is permitted to remain should be kept in mind.

It is a curious and unexplained fact that "the stone" is now a much less common malady than it formerly was.

MOVABLE OR "FLOATING" KIDNEY

It is decidedly true that in most diseases misinformation is harmful, and in no disorder is this so conspicuous as in the so-called movable kidney. As a matter of fact all kidneys are somewhat movable, particularly in women, the right more than the left, descending with inhalation and ascending with exhalation.

In thin persons with poor posture, who permit their abdomens to sag forward, the movement of these organs is somewhat more marked, the right being frequently palpable during examination. In extreme instances, pain and discomfort in the region of the right kidney may result, but if a doctor is unwise enough to say that the kidney has "dropped" or fallen, many patients immediately magnify or imagine discomfort in its region, and become so convinced of the presence of serious disease that they can seldom be persuaded to believe otherwise. In the small proportion of cases in which mechanical symptoms develop, training in posture is advisable not only because of the kidney, but to correct the poor posture which usually accompanies the condition. While surgical procedures have been undertaken in cases of movable kidney, the result has often been a continuance of ill health due to nervousness, and increase rather than diminution of the local discomfort, even though the position of the kidney has been rectified. For this reason most surgeons are unwilling to perform such operations.

TUMORS OF THE KIDNEY OR BLADDER

Among the relatively rare diseases, tumors of various kinds develop in the kidney or in the wall of the bladder. Some of these are malignant, causing increasing symptoms as they progress, and also tending to the formation of secondary (metastatic) tumors in other parts of the body. If diagnosed sufficiently early, tumors of the bladder and sometimes those of the kidney may be removed surgically with hope of eradicating the disease.

Much more frequent and grave are the tumors of the prostate gland.[1]

HEMORRHAGE OR BLEEDING FROM THE URINARY TRACT

Blood in the urine, except that which is visible during menstruation, is always a symptom requiring medical investigation. There are various conditions that may cause blood to appear in the urine, some of which are relatively unimportant; but it may be the first symptom in serious disorders, such as tumors or tuberculosis, when great advantage is to be derived from prompt treatment. Modern methods in diagnosing diseases of the urinary tract have become highly specialized and yield evidence which it was impossible to obtain in such conditions a generation ago.

KIDNEY PAIN FROM CAUSES OTHER THAN STONE

The pain which originates in either kidney is often peculiarly variable in its character as well as in its location. Ordinarily, it is referable to the flank somewhat toward the back, under the lowest ribs. Sometimes, however, it is more distinctly in the back and may be mistaken for lumbago, while in other instances it may be referable to the abdomen, like the pain of gallstones or appendicitis, or gastric or intestinal indigestion. There are even times when the pain of a diseased kidney has been located in the region of one not diseased. Therefore, the diagnosis of painful diseases of the kidneys is frequently perplexing, particularly in its differentiation from other causes of abdominal pain. It is becoming increasingly evident in medical practice that obscure cases of abdominal pain require a searching examination of the urinary system. But possible disease of a kidney is more likely to be related to pains in the abdomen or flank, than to backache.

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[1] See section on Operations for Conditions Other than Injuries in chapter entitled Surgery, p. 391.

CHAPTER XXXI

DISEASES OF THE NERVOUS SYSTEM

It has been explained elsewhere that the nervous system consists of (1) the peripheral nerves, (2) the spinal cord, and (3) the brain. Like all other tissues of the body, these are subject to alterations in structure resulting from injury or from disease. Such changes may be recognized and analyzed by means of anatomical or microscopical examinations in those whose death has been caused by them, and in this way it has become possible to determine and understand the nature and extent of many of the various symptoms which may occur in the living organism. The study of nervous disorders is a highly specialized branch of medicine, and despite the strides already made, it is still imperfectly comprehended. There are nervous disorders presenting specific symptoms in the way of alterations in or loss of function which show corresponding abnormalities of structure; there are others in which the peripheral nerves, the spinal cord, or the brain reveal no structural defects although they undoubtedly participate in the disease. Each disorder, however, in addition to its own ramified pathology, bears a relation to the nervous system as a whole. Thus, for purposes of study, the diseases of the nervous system are rather definitely divisible into two groups, the first constituting those in which there are known changes of structure in nerve tissue, and the second of diseases in which such changes of structure cannot be found. This distinction is likewise observed in studies of disorders of the mind.

Here it may be well to reiterate that the terms "nervousness" and "nerves," of ordinary conversation, are only remotely related to what may be properly considered diseases of the nervous system, which are marked, in the major disorders, by such symptoms as paralysis or unconsciousness. "Nervousness" on the contrary may occur when the brain, spinal cord, and nerves are intact, representing only overactivity of its normal functions, which may be an inherited peculiarity of the individual. Oftentimes "nervousness" is a symptom of disorders other than those related to nerves, as in diseases of the thyroid gland, or of the female genital tract. Most frequently, perhaps, it is due to maladjustment to environment. Essentially it is a peculiarity of reaction of the nervous system, as part of the body as a whole, rather than a primary disease of the nervous system.

However, subsequent reference is made to certain special forms among disorders of the mind and personality.[1]

DISORDERS OF PERIPHERAL NERVES

Injuries to Nerves.—In wounds, the trunks of nerves lying in their course are divided, thus destroying the function of the nerve. If it is a motor nerve, a flaccid paralysis of the muscles supplied by it result; and in the case of a sensory nerve the part of the body from which that nerve transmits impulses is deprived of sensation. If the wound is clean-cut so that the ends of the divided nerve lie in close contact, or if the cut ends are sewed together, the nerve will heal and will subsequently resume its functions. If, however, the wound heals leaving a gap between the ends of the nerve the resultant loss of function will be permanent.

Neuritis.—The term neuritis is properly applied to actual inflammations of peripheral nerve trunks, but it is also commonly used to denote changes of structure which are, in reality, degenerations and not inflammations. Neuritis may occur in any nerve, but the sciatic nerve which extends from behind the hip into the thigh, and the nerve trunks which lead to the shoulder and arm are those most frequently affected. Although the term neuritis is usually suggestive of pain, as in sciatica and in neuritis of the arm, there are other important varieties not marked by pain but by paralysis, with wasting or atrophy of muscles. Still other symptoms of disturbed nerve function are *anœsthesia* or loss of sensation, and *paræsthesia* or unnatural sensations other than pain, such as numbness, tingling, etc., which are often persistently annoying.

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[1] See sections on the Psychoneuroses or Minor Mental Abnormalities and Neurasthenia in this chapter, pp. 370, 376.

Painful neuritis may occur from some obscure causes, but continued pressure, vibration, and other mechanical injury to the nerve are frequently contributory factors. In other instances, a focus of infection in some other part of the body may be responsible. Prolonged rest of the affected nerve together with the removal of any existing local infection are the therapeutic measures most likely to effect recovery.

Many cases of peripheral neuritis with paralysis are the result of some chronic poisoning, chiefly from alcohol, from lead, or from arsenic. An occasional variety is that due to pressure upon a nerve, as when an intoxicated person sleeps heavily in such a position that the weight of the body rests on the outer side of the upper arm until the wrist becomes powerless. Diabetes and some other grave disorders are at times accompanied by degenerations of the peripheral nerves.

Facial Paralysis.—In its course from the brain, the nerve which controls the muscles of the face passes close to the middle ear and, in consequence of inflammations of the ear, or as a result of refrigeration, as well as from other obscure disorders, this nerve sometimes becomes paralyzed. The result is a loss of motion of one-half of the face, which may be temporary or permanent. There are many other instances of paralysis of peripheral nerves.

Neuralgia.—Neuralgia is the term applied to paroxysmal pains occurring in the distribution of a certain nerve. In contrast with neuritis there is no evidence of structural change in the affected nerve. Despite its characteristic symptoms the cause is practically unknown, save for the fact that in many cases there is an inflammation of some structure situated near the nerve.

The most severe neuralgias are those of the face involving either the whole of one side of the face, or only the upper, middle, or lower portions. The pain is paroxysmal, rather than continuous as in neuritis, but may be extremely severe. In some cases there is inflammation of a tooth-root, pressure from abnormal growth of a wisdom tooth, or disease of a nasal sinus, and the correction of such conditions sometimes results in recovery. In severe cases in which other relief cannot be obtained, operations are performed to destroy the nerve.

Among the other forms of neuralgia, that which affects the back of the head at its junction with the neck and that involving a shoulder or an arm are the most frequent. In these and in other cases that present symptoms of neuralgia, abnormal habits of posture and also arthritic changes in the vertebræ may be factors.

Occupation Neuroses.—Of these the most important is writers' cramp. In persons whose occupations involve the performance of specialized movements hurriedly and under strain, as in writing, there sometimes develops a loss of control of such movements, occasionally with cramplike spasm. The precise mechanism of this disorder is not understood. Sometimes neuritis of an arm and writers' cramp is caused by a malposition of the shoulders whereby the *scapula,* having lost its flatness, tends to bend toward the front of the body and so exerts pressure upon the nerves of the arm; such a condition is curable by operation on the scapula. Complete rest of the hand as promptly as possible after the onset of symptoms is imperative, since the longer the condition is neglected or resisted the longer it will persist. At a later stage special exercises are indicated.

Herpes Zoster or Shingles.—This disease is of rather frequent onset and manifests itself by lesions somewhere on the skin resembling groups of cold sores, usually arranged in a bandlike area corresponding to the distribution of a nerve in the affected region, combined with pain which seems to radiate through it. The condition is always confined to one side of the body. There are structural changes at the nerve-root caused by destructive inflammation of the nerves involved and followed by their obliteration and paralysis which are believed to be the cause of the disorder. Ordinarily, the eruption and the pain subside in a week or two. Occasionally, and particularly in old persons, an obstinate, painful neuritis persists indefinitely.

DISEASES OF THE SPINAL CORD

Infantile paralysis or *anterior poliomyelitis* has been mentioned under the acute diseases. With the exception of locomotor ataxia or *tabes dorsalis,* other diseases of the spinal cord, including injuries, tumors, and various rare forms of spinal paralysis, are so comparatively rare as not to require discussion.

Locomotor Ataxia.—Tabes dorsalis or locomotor ataxia is syphilis of the spinal cord. It is a disease usually of late middle life, developing as a rule some ten or more years after the initial syphilitic infection, during which time the disease has frequently been quiescent or even forgotten. The onset is gradual and usually manifests itself by various disturbances of sensation of the legs or other parts of the body, such as numbness, tingling, sharp shooting pains known as "lightning pains," or a sense of constriction about the body. In some cases violent attacks of abdominal pain are present. Finally, there develops the symptom from which the disorder derives its name, that is, *ataxia,* which is an inability to coordinate the muscular movements, as in walking. This irregularity of function is due to a degeneration and wasting of certain tracts of the spinal cord and of the sensory nerve trunks, the result of disease. And this consequent alteration in structure of the spinal cord prevents the normal, automatic conduction of the sensory impulses that reach the spinal cord from the lower extremities. Instead of the harmonious motor impulses necessary for walking, misdirected impulses are produced, resulting in a disorganized gait. The feet cannot be moved and properly planted, and walking consequently becomes difficult. Conscious attention to each movement somewhat overcomes this difficulty, so that patients who have tabes usually devote close attention to each movement which is made in walking; they look fixedly at the ground, or even at each foot. It is characteristic that in the dark they have much more difficulty in getting about. One diagnostic test to establish the presence of the disease is to have the patient stand and then close his eyes; patients with ataxia begin to sway, or will even fall, as soon as the eyes are closed since they depend largely on the sense of sight to maintain their balance. There is also loss of coördination in movements of the upper extremities, the patient being unable to place the forefinger accurately on the nose with closed eyes. These disorders become a serious handicap and may be completely disabling. Visual disturbances, difficulty in voiding urine, enlargement of joints and other less constant symptoms occur.

While tabes dorsalis was formerly considered entirely incurable, some success in arresting its progress has been attained during recent years provided the disorder is recognized in its early stages. The possibility of syphilis of the nervous system as an eventual outcome of the primary disease is one important reason for prompt and thorough treatment of all cases of syphilis, and for immediate attention to any warning symptoms even years after the original infection. In the fully developed cases, something may be accomplished by systematic training in the control of muscular movements.

In certain cases of pernicious anæmia[2] and of diabetes[3] there are symptoms similar to those of locomotor ataxia, resulting from changes in the spinal cord.

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[2] See section on Pernicious Anæmia in chapter entitled Diseases of the Blood, p. 287.

[3] See section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

DISEASES OF THE BRAIN

Apoplexy.—Of organic diseases of the brain, cerebral hemorrhage or apoplexy is by far the most frequent. In fact, a "shock" or "stroke" of apoplexy is so common a termination of life in very old people as to seem almost physiologic in extreme old age. But the condition may occur prior to senility, particularly in those with elevated blood pressure.

Apoplexy is due to the rupture of an artery in the brain, with resultant bleeding into the brain tissue. Its onset is sudden and it may be immediately fatal, but in many cases, after a period of unconsciousness usually lasting less than twenty-four hours, when consciousness is regained, there is found to exist a paralysis of one side of the body, or of one arm, of one leg, or of one side of the face. Since voluntary movement of either side of the body is controlled by the opposite side of the brain, a hemorrhage occurring in the right hemisphere produces paralysis of the left arm or leg or both, and vice versa. The speech centers are in the left hemisphere of the brain; therefore, hemorrhage in that side results, not only in paralysis of the right arm and leg, but also in loss of the power of speech. Such inability to speak is called *aphasia.* It may be permanent or temporary, although recovery is seldom complete. Inability to write (*agraphia*) is frequently an accompaniment.

Paralysis due to structural impairment of the brain differs from the paralysis of peripheral neuritis, or of infantile paralysis in that the paralyzed muscles are rigid, or under a certain degree of tension, instead of being completely flabby. Therefore, when a leg or arm is paralyzed after apoplexy it becomes somewhat stiff. For this reason some patients with apoplectic paralysis are still able to use the paralyzed leg a little in walking, somewhat as they would a wooden leg.

After a stroke of apoplexy it is impossible to predict whether recovery will occur, so long as the patient remains unconscious. When consciousness is regained, survival may be expected. The extent of the paralysis is exceedingly variable, much improvement frequently occurring in the course of subsequent weeks or months so that the patient is able to go about in spite of it.

There is another condition with results identical to those of apoplexy. This is known as *embolism of the brain,* and is due to obstruction of an artery in the brain by a fragment of blood-clot which has formed in the heart as the result of endocarditis,[4] but has broken loose and has been carried into the blood-stream. Thus in younger patients, attacks resembling apoplexy are occasional complications of endocarditis.

Certain old people have seizures of unconsciousness simulating apoplexy from which they completely recover within a few minutes or hours. Several such attacks may occur. They are believed to be due to partial closure of arteries of the brain by arteriosclerosis, without hemorrhage.

Tumors of the Brain.—Tumors of the brain form an important group of serious brain disorders. In typical cases, the chief symptoms are gradually increasing headache and loss of eyesight, due to intracranial pressure. In other cases, headache is not prominent but mental deterioration is the conspicuous result. There may be paralysis. In the earlier stages of the disease, the diagnosis of brain tumor is usually a matter of uncertainty, but when the symptoms become pronounced it is frequently possible to determine, not only the existence of a tumor, but also its exact location. In some instances, tumors of the brain are removable, but such operations are among the most difficult and uncertain in all surgery. For tumors of the brain that cannot be removed, temporary relief may be afforded by making an opening in the skull to relieve the intracranial pressure.

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[4] See section on Diseases of Heart Valves in chapter entitled Diseases of the Heart and Circulation, p. 271.

Syphilis of the Brain.—Aside from locomotor ataxia, syphilis of the central nervous system includes two types of disorders involving the brain: (1) meningovascular neurosyphilis; and (2) general paresis. The first makes its appearance not long after the primary syphilitic infection, or perhaps within a year. The second develops considerably later in the course of the disease, or five to forty years after the original lesion.

Meningovascular neurosyphilis. This disease has various manifestations, but in many cases the condition is one of more or less acute illness, somewhat resembling other varieties of meningitis, with headache, stiffness of the neck, and stupor. In other instances, there are local paralyses as of the muscles of the eyes or of a limb, or disturbance of speech. There may be mental symptoms simulating those of general paresis but these are relatively infrequent. This form of neurosyphilis is strikingly amenable to the intensive systemic treatment of syphilis, supplemented by certain special methods.

General Paresis. General paresis is one of the most important varieties of insanity. Its earlier manifestations are marked by progressively increasing loss of mental faculties rather than by evidence of bodily disease, the usual primary symptoms being changes in personality, often marked by poor judgment in business, inattention to care of the person or dress, and general slovenliness. In these early stages of the disease mismanagement of business affairs and indiscreet actions, sometimes disastrous in their social results, often occur before the abnormal condition of the individual is apparent. The mental deterioration gradually becomes more distinct, finally constituting obvious insanity. In some cases, there is a curious tendency to the so-called delusions of grandeur, and insane ideas of importance and wealth. In other instances there may be maniacal excitement, or depression, or simply deterioration of mentality.

Physical symptoms likewise occur but as a rule only after the mental disorder has developed. Most patients have convulsions similar to those of *epilepsy* some time in the course of the disease. Weakness, tremulousness, and inability to perform delicate movements such as those necessary in writing are frequent. This inability to write may be complete, or it may be confined to simple omission of letters. Disorder of articulation and intonation, which may become so profound that the victim of the disease cannot make himself understood, is of frequent occurrence.

The face is apt to become immobile and expressionless or masklike. Inequality of the pupils, and irregularities of outline and alteration in the size of the pupils in varying conditions of light are always suggestive of the disease.

Examination of the brain at autopsy reveals pronounced macroscopic and microscopic changes. Although the disease is sometimes referred to by the fanciful term "softening of the brain," the brain tissue is actually firmer or harder than normal. An important method of diagnosis is the withdrawal by lumbar puncture of some of the fluid which surrounds the brain and spinal cord, and subjecting it to biological and chemical examination.

Save as modified by modern methods of treatment, the condition is progressive and fatal, usually from one to five years after diagnosis is established. The later stages are marked by increasing loss of mentality, and the physical symptoms may range from weakness and emaciation to complete paralysis.

The disease was formerly completely refractory to treatment, but within recent years the development of a number of modern methods has resulted in the improvement or arrest of some of the cases

DISEASES OF THE NERVOUS SYSTEM WITH PHYSICAL MANIFESTATIONS BUT WITHOUT ESTABLISHED PATHOLOGY

Paralysis Agitans or Shaking Palsy (Parkinsonian Syndrome).—This is a disease of the fifth and sixth decades of life. Its cardinal symptoms are immobility and tremor, the former being universal, the latter confined usually to the hands. Disorders of articulation and intonation are likewise present. The tremor is absent during sleep, but throughout the waking hours it is continuous while the patient is unoccupied, although it may usually be terminated by conscious effort, that is, when attention is directed to controlling it.[5] All voluntary movements become difficult because of a certain tenseness or rigidity, and in walking there is a characteristic tendency to fall forward, sidewise, or backward. The face becomes immobile or masklike. The patient gradually becomes unable to follow his usual occupation because of physical disability, but there is as a rule no mental deterioration save that proportionate to age. In certain cases there is no tremor, although the condition is recognizable by the presence of its other characteristic symptoms. The disease progresses despite any known treatment, although muscular training by special exercises may be of some value.

Encephalitis lethargica or sleeping sickness is frequently followed by an identical condition of progressive rigidity and tremor which, when due to this cause, may develop at any age even in childhood.

Epilepsy.—This is a disorder characterized by the repeated occurrence, at varying intervals, of seizures of unconsciousness usually accompanied by a convulsion. As this condition causes much needless anxiety to parents, it should be explained that the convulsions which occur so frequently in young children from diverse causes apparently bear no relation to epilepsy. In fact, a diagnosis of epilepsy is not even justified on the strength of a single convulsion in later life, but only after the repeated occurrence of such attacks. There are other causes of this symptom in adults as well as in children. Any such seizure is reason for consulting a physician, who in many instances will be able to determine the cause and at times to relieve the condition.

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[5] Another occasional disorder in which tremulousness is sometimes conspicuous is *multiple sclerosis,* a chronic disease involving organic changes in the brain and spinal cord. The tremor in this condition differs from that in paralysis agitans in that it is minimized when the patient is relaxed or at rest, but increases greatly as soon as attempts are made to resist it, so that the finer movements are completely impossible.

True epilepsy, however, is incurable. Something may be done to diminish the frequency of the attacks, and there are certain precautions to be observed to avoid the occurrence of convulsions in places where a fall would be dangerous. But true epilepsy must be accepted as a permanent handicap, in some instances producing mental changes. As the patient is usually rendered incapable of self-support because of the nature of the disease, the condition is doubly unfortunate; for this reason public institutions should be established for the care and maintenance of epileptics.

Migraine.—Sick headache is a constitutional disorder involving the more or less periodic occurrence of headache referable to one side of the head, with vomiting, and frequently with disturbances of vision. There are various theories concerning its cause, but a disturbance of the circulation in the arteries of the head and of the eyes seems to be a causative factor. The tendency to sick headache is apparently hereditary in the great majority of instances. On the other hand, there are undoubtedly other conditions which precipitate attacks, such as eyestrain, emotional excitement, digestive disturbances, errors of diet, and perhaps individual sensitiveness to certain foods.

The treatment of sick headache lies chiefly in regulating the mode of living and in removing precipitating factors, in order to render them less frequent. Various forms of treatment give some relief in certain cases. Usually the disease disappears during or after middle life.

Headache.—Headache proper (to be distinguished from migraine and also from neuralgias which are often confused with headache) must be considered a symptom connected with the nervous system, although the exact mechanism of its production is unknown. It occurs temporarily in almost every one from a variety of causes—with the onset of fevers, after alcoholic intoxication,[6] from the use of various drugs, in connection with constipation or digestive disorders, after exposure to heat and sun and the like. Extreme headaches occur in certain organic diseases, notably in nephritis and in tumor of the brain.

But by far the commonest type of headache is that which recurs frequently in certain individuals, or may be present in varying degrees constantly, without other symptoms or signs of disease. Such headaches are seldom incapacitating but are a source of serious discomfort, and figure as persistent handicaps to satisfaction and efficiency in life.

The tendency to such headaches is best considered as an unfortunate personal characteristic of the individual, sometimes inherited. As mentioned, the exact cause or mechanism of the headache is unknown. Careful studies of all vital functions reveal no constant abnormalities.[7] Autopsies upon the bodies of persons who have been lifelong sufferers from headache have revealed no explanation, either in the brain or elsewhere. The cause must therefore be some elusive departure from normal too slight to be detected objectively but sufficient to produce the symptom in these individuals.

But while the susceptibility to headaches seems to be an inherent tendency of the individual, there are many precipitating causes that may be responsible for any particular attack. The factors that may produce headache in any one produce it more readily in those who have this susceptibility. In addition, there are factors which normal persons do not have to consider but which headache sufferers have to avoid carefully. Eyestrain of various sorts, typified by the headaches which some persons have after viewing moving pictures, is an important producer of headaches. Oversensitiveness to heat, to "close" atmosphere and odors, to conditions of pressure within the nasal cavity due to slight abnormalities, and to noise may be mentioned.

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[6] The headache of the "morning after" is due much more to impurities of liquor known as higher alcohols than to ethyl alcohol itself.

[7] Except that in certain cases of headache due to organic causes, when the pressure of the cerebrospinal fluid has been tested it has been found to be increased.

There is also a class of factors that may be grouped together under the general head of fatigue of the nervous system. Intense mental concentration may be followed by headache. Curiously typical is the headache, usually referable to the back of the head, that occurs in connection with business worries. Not only mental effort but also emotional episodes are productive of headaches which may be supposed with some plausibility to be due to overuse or strain of the mental functions involved.

Finally, it deserves mention that the symptom of headache is frequently exaggerated, as the result of solicitous overattention, until it occupies a more prominent position in the consciousness than its actual severity warrants. And beyond such instances there may perhaps be headaches that are entirely hysterical in their origin.

Persons who are subject to headache, and still more those in whom headaches develop as a new symptom, should consult a physician with a view to ascertaining the cause. The physician will consider a considerable list of the organic causes of headache, only a few of which have been mentioned in this discussion. If an organic cause is discovered, the treatment is the treatment of that cause. If contributing or precipitating factors are identified, as in poor eyesight, these deserve appropriate attention. If, however, there is no discoverable organic disease, and the blame must therefore be laid upon the factors of mental and emotional fatigue acting in the presence of a constitutional susceptibility, chief reliance is to be placed upon regulation of the mental and emotional life. If, by careful training, the mental effort can be systematized and limited to that which is necessary and profitable, and if the emotional reactions can be stabilized, both by self-restraint and by correcting the environmental factors that play upon them, improvement will often follow.

RARER DISEASES OF THE CENTRAL NERVOUS SYSTEM

There are many other disorders which are obviously diseases of the nervous system. For the most part these are chronic, progressive, and incurable. Some are manifested by paralysis and wasting of muscular tissue, others by rigidity or spasticity of muscles, others by disturbances of sensation, and still others by mental deterioration or insanity. Some of these are known to be the result of alterations in structure of the brain or spinal cord, while others are still unexplained on the basis of any underlying structural change despite their characteristic symptoms.

Lethargic Encephalitis or Sleeping Sickness.[8]—This is a disease which appeared in a wave of prevalence in the years following the last influenza epidemic but which has now subsided into rarity. The attack itself is marked by a state of partial stupor with slight fever, often with paralysis of the eyes or face and sometimes with convulsions. It may be fatal. But a peculiar and distressing feature of the disease is that, in a considerable proportion of the cases that survive, there develop, in subsequent years, chronic and permanent disorders of the nervous system, notably the Parkinsonian syndrome and mental changes.

Chronic Choreas.—The common and temporary acute form of chorea has been mentioned under the acute diseases. There are other somewhat similar forms which are chronic and permanent.

Multiple Sclerosis.—This malady has been mentioned, with reference to its characteristic tremor.[9] It is a disease which manifests itself gradually in a succession of attacks, with each one of which the symptoms become permanently more pronounced. While its cause is unknown, it seems to be becoming more prevalent.

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[8] Not to be confused with African sleeping sickness, due to an animal parasite in the blood conveyed by a certain fly.

[9] See footnote in section on Paralysis Agitans in this chapter, p. 358.

Progressive Muscular Atrophy.—This is a chronic disease in which degenerations of nerve-cells result in extensive wasting of muscles. The "living skeletons" of circus side shows are instances of this disease.

A list of still rarer diseases could be extended indefinitely.

The effects of these disorders of the motor elements of the nervous system may be classified for purposes of treatment in three groups: (1) spastic ("stiff") paralyses—to be benefited by passive and active assistive manipulations and exercises; (2) ataxias or difficulties in controlling motion—to be treated by reëducational training; and (3) flaccid paralyses with atrophy of muscles—for which massage, electricity, and especially the mechanical methods of orthopedic surgery[10] are indicated.

MENTAL DISEASES

Before discussing disorders of the mind, it may be well to explain that the term "insanity" is a legal rather than a medical one. In pronounced instances of mental disorder it is, of course, obvious that the patient is "not in his right mind" or "insane." On the other hand, there is no definition in medicine which draws the line between sanity and insanity. Therefore, despite the expert medical counsel usually obtained, any decision made by a court in regard to sanity must be arbitrary, since no exact criteria are applicable. Practically, insanity may be defined as a state of mind or personality which renders an individual either so incapable of caring for himself, or such a menace or detriment to the community, that he should be committed to guardianship or to an institution.

Abnormalities of the mind or of the personality may be grouped in two large divisions: (1) those which, like general paresis, are the result of distinct tissue changes in the nervous system; and (2) those in which, despite minute search, no objective changes in the structure of the brain are demonstrable.

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[10] See chapter entitled Orthopedic Surgery: Diseases of the Bones, Joints and Muscles, p. 395.

In addition to general paresis,[11] there are various mental disorders due to structural alterations in the brain, the result of disease other than syphilis. Among these may be mentioned· (1) delirium, in fevers or other bodily diseases such as typhoid fever or pneumonia; (2) the form of temporary insanity which sometimes follows childbirth, and probably results from infection of the womb; (3) insanity due to tumor of the brain; (4) pellagra; [12] (5) mental disturbances in old age connected with changes in the brain due to arteriosclerosis; (6) *senile dementia,* another mental disorder of old people, with alterations in the brain tissue apparently not the result of actual sclerosis although the symptoms resemble those of arteriosclerosis of the brain; (7) insanity or mental changes due to chronic alcoholism, to drug addiction, or to other chronic poisonings; (8) mental disturbances associated with chronic disorders of locomotion or of sensation, as that following *epidemic encephalitis,* or that connected with various conditions of spasm or paralysis. In all cases of insanity or of mental deterioration, the physician's first step in diagnosis is to seek evidence that justifies the classification of the condition under one of these heads. In some instances, the mental symptoms of typhoid fever or of infection after childbirth or of lead poisoning may be so conspicuous as to overshadow the physical manifestations of the underlying disease. In mental symptoms which have their origin in chronic degenerations of the brain, loss of memory and inability to reason or to calculate may be typical changes, but emotional instability, from excitement and elation to depression of spirits, may also be pronounced. Mental disorders due to self-limited diseases are usually transitory; those caused by chronic degenerations are ordinarily progressive.

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[11] See section on General Paresis in this chapter, p. 356.

[12] See section on Diseases Due to Vitamin Deficiency in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 335.

Disorders of the mind which are not the result of structural alterations in the brain, or of bodily disease, are differentiated only by their typical symptoms and by the courses which they tend to follow. By observation and study of great numbers of insane persons, it has been recognized that most cases may be classified as belonging to one or another of a relatively small number of types, notwithstanding their individual points of difference. But since abnormal thought and behavior are usually the only symptoms by which diagnosis is possible, it is frequently difficult to classify the disease with certainty, particularly in its early stages. Often it is only by continued observation that the conclusions become more definite. However, the classification and subsequent diagnosis of mental disorders is extremely important, as the probable course and outcome of the disease can often be predicted with a considerable degree of certainty.

Manic-Depressive Psychosis.—This very frequent mental disorder is fundamentally a disturbance of the emotional state tending to extremes of feeling. The patient's temperament undergoes a change, either toward unnatural happiness and elation, or toward unhappiness, depression, and extreme mental suffering, the former usually accompanied by a sense of power and by sudden impulses to act in a foolish and often violent manner, while the latter may be associated with feelings of unfitness, and with a slowing of thought, of speech, and of action. The first of these stages is known as the *manic phase* or *mania;* the second, as the depressive or *melancholia.* The two are directly opposite, but the same patient may pass from either one to the other, or may be subject to one or the other in different attacks. Both forms, however, are usually transient abnormalities, continuing for a few weeks or even for a year, after which there is a return to normal. In many cases there are repeated attacks of mental disorder, after long intervals.

Perhaps the most important point in connection with the treatment of either phase of this disease is that the patient's abnormality should be recognized as early as possible so that necessary precautions may be observed. In the depressive stage particularly, suicidal impulses may be present, and the danger that such impulses will be obeyed is greatest, either when the attack first manifests itself, or, much later, after recovery is seemingly complete. At the height of the disorder the patient is usually incapable of such action. During the manic phase early precautions are likewise necessary, since the patient is most likely to succeed in irresponsible acts of mischief before his insanity is obvious.

The treatment in both forms is commitment to a hospital for mental diseases, where the patient can harm neither himself nor others. While there is no directly curative measure, special management is very necessary, often including artificial feeding to prevent starvation, prolonged hot baths and occasionally drugs to diminish excitement, as well as supportive treatment during depression. The period of confinement should not be terminated prematurely.

Involution Psychosis.—Mid-life depression. This disorder, occurring chiefly in women during or near the menopause, is probably a form of manic-depressive psychosis, but is more frequently complicated by delusions of bodily disease. The duration of the attack may be two years or more, but eventual recovery is the rule.

Dementia Præcox or Schizophrenia.—Schizophrenia means a splitting or an incoördination, or an incongruity of the various mental and emotional processes, such dissociation being its fundamental characteristic. Victims of this disease react emotionally in unnatural and irrational manners. Thus they may say, in a matter-of-fact way and wholly without emotion, that they are about to be murdered, or they may show no remorse or regret after criminal acts, either real or imaginary. As indicated by the name dementia præcox, the abnormality may develop early in life, although in some of the milder instances it is not apparent until later. Frequently, the patient has been recognized to be rather peculiar from childhood, tending at times to be solitary or subject to tempers and to extreme obstinacy. Day-dreaming and a tendency to an imaginary mental life are characteristic. At or soon after puberty, the changes become more marked and the patient is usually recognized to be abnormal. In milder cases, lack of interest, absence of ambition, and a general apathetic attitude toward the realities of life are characteristic. Frequently, the individual drifts into vagrancy. Another type of more pronounced grade is a silly deterioration varied by a tendency to solitary day-dreaming, the patient tending to converse with himself and with imaginary persons, from which it is evident that there exist not only delusions, but also hallucinations or seeing imaginary sights and hearing imaginary sounds. Still more striking, and usually after a longer period of distinct but less marked abnormality, there may be periods of excitement and of stupor often difficult to distinguish from those of manic-depressive psychosis. Another rather constant feature of cases of dementia præcox is delusion. Sometimes these are systematized. Patients are convinced that persons are in conspiracy against them, and their reasons for holding these beliefs, if they can be persuaded to give them, are sometimes fantastic and absurd. Often also they believe that they are in direct communication with God, with the devil, or with dead relatives, often hearing imaginary voices. Delusions on sexual subjects are said to be almost universal among them.

The cause of dementia præcox is still a matter of doubt, but two opposing views are held. One school of thought believes that the disease is due to a disorder of inheritance or of development, inherent in the individual's personality; the other is collecting evidence in support of the theory that earliest influences of environment and associations may be an important factor, and particularly difficulties of adjustment in the sexual sphere. Future investigations may determine the question.

In all cases the outlook is discouraging. While a few patients are able to maintain themselves safely outside of institutions, and some improve sufficiently to return to the community after institutional treatment, the great majority have to be maintained in hospitals permanently because of increasing abnormality. Early recognition of the disease, and appropriate education and training before adolescence, are believed by some authorities to be of value.

Paranoia.—Paranoia may be regarded not as a disease but as an extreme peculiarity of the personality, or eccentricity of such grade as to render the individual clearly abnormal. It often assumes well recognized types. The religious type is perhaps the most characteristic, as illustrated by many religious fanatics. In the litigious form of paranoia the individual is unreasonably addicted to pressing claims in court. In the inventive type, the life is devoted to working upon fantastic inventions. The socialistic type is perhaps the most serious, since it occasionally leads to violent acts such as assassination. The abnormality is a permanent one, and is entirely uninfluenced by argument or by logical explosion of fallacious ideas, or by any other treatment. While as a rule paranoiacs are perfectly harmless, the more pronounced cases must be committed to institutions, either because they are unable to care for themselves or because they become a nuisance or danger if permitted to be at large.

Epileptic Mental Disorder.—While epilepsy, as described elsewhere,[13] is chiefly characterized by periodic convulsions, most of the patients also show mental deterioration, some having violent mental symptoms which may be even more serious than the convulsive attacks. The mental changes often take the form of irritability and pugnacity, in the extreme of which the patient may become very dangerous.

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[13] See section on Epilepsy in this chapter, p. 358.

Constitutional Psychopathic State.—Under this head are grouped many peculiarities of personalities. One form is a nervous and emotional instability manifesting itself in unreasonable fits of anger, or in a lack of normal sentiments or of ethical sense. The so-called kleptomaniacs, or persons who steal as the result of irrational impulse, not because they are in want but because they cannot help it, come under this class. The actions of many criminals may be explained by similar tendencies. It is disputed whether the abnormalities are inherent from birth or are developed from influences of early environment. In a few there is improvement as life goes on, and it is held by some that reëducation in adult life is of value. This question is now the subject of active discussion in connection with the treatment of criminals but it is still unsettled.

Feeble-Mindedness.—In children, failure to develop mentally is sometimes a consequence of serious disease or injury in early life. In other instances the developmental defect remains unexplained. Latterly it has become established that certain persons of subnormal mentality have inherited this unfortunate characteristic from parents or grandparents similarly deficient.

It is extremely important that the mental limitations of these unfortunates be recognized as early as possible, for it is useless and harmful, as well as productive of unhappiness, to attempt to force them beyond their powers. The object should be to determine their various capacities as accurately as possible, to cultivate such powers as can be cultivated, and to effect a social and an economic placing appropriate to the individual.

Considerable advance has been made in the education of backward children, so that some are able to follow useful occupations in later life. Marriage by the mentally deficient is undesirable and has been made illegal in some states.

THE PSYCHONEUROSES OR MINOR MENTAL ABNORMALITIES

The graver mental disorders so far described are, fortunately, of exceptional occurrence; but, although our understanding of many of them is meager, in all of the pronounced grades there is obvious necessity for the treatment furnished in hospitals for the insane. A much larger and almost equally difficult problem is presented by minor disorders of the mind or personality called *psychoneuroses,* which are the probable basis of most complaints of ill health. So widespread and numerous are the complaints based upon mental disturbances, or upon bodily disorders without recognizable physical changes the effects of which are clearly exaggerated by the mind, that cults such as Christian Science and Mental Healing have been able to come into being on the assumption that no other form of disease exists. If, in the absence of physical disease, undesirable mental reactions could be avoided much discontent would certainly disappear, and, even in actual disease, complaints would be greatly diminished.

These mental abnormalities, which loom so large in the consciousness of those who have them but seem so unnecessary to the casual observer, have been studied intensively of late years by investigators of psychology. In fact, this newer psychology has developed into an important branch of science, the practical applications of which have bearings upon both education and medicine.

MEDICAL PSYCHOLOGY OR MENTAL HYGIENE

In tracing the mental characteristics of the individual, psychology regards *inheritance from the ancestry* as the first factor, showing that particular traits and abnormalities follow the same laws that govern all physical inheritance. But also, in conjunction with this predestined and immutable factor, it lays stress upon the influences of *environment,* from birth and infancy onward. These, fortunately, can be modified by careful attention so that harmful effects may be avoided and better results attained.

In tracing the influences of environment,[14] psychology shows that in the infant the movements or other actions, in response to external circumstances or "stimuli," soon tend to be the same with each repetition of the stimulus, or whenever the child finds himself in the same situation again. The fundamental fact seems to be that any response, or translating of sensory or perceptive impulses into motor impulses, tends to become fixed by successful repetition, or, in simpler language to become habitual. This factor of habit, using the term in its broadest sense to include both the simplest acts such as the winking of an eye and the most complex such as an outburst of temper, must be recognized as a commanding force in determining the individual's nervous and mental reactions.

The responses to particular stimuli that become fixed or habitual by repetition are not confined to the logical or purposeful actions that each stimulus would be expected to produce. There are in addition illogical or accidental reactions that become no less fixed. In the simpler forms these are called *conditioned reflexes,* of which the following is an illustration. If, while a dog is being fed, a bell is always rung, it is found in the course of time that the ringing of that bell will cause that dog's saliva to run and produce swallowing movements even though no food is given. The ringing of the bell thus serves as what is called an *associated stimulus,* or an accidental influence producing an illogical result because of habit formation through repeated association. Undoubtedly this mechanism of the conditioned reflex likewise enters into our more complex mental functions, as, for instance, in instinctive prejudice against a person because he bears a resemblance to an enemy, even though that resemblance is not consciously recognized.

In connection with these conditioned reflexes, developed according to the more or less accidental associations of the individual so as to cause reactions peculiar to the individual, we must also take cognizance of what are known as *inhibitions,* controlling or suppressing these reactions. An inhibition is an influence or stimulus that deters from action, and, in the psychological sense, it usually applies to an influence that inhibits or prevents, in a certain individual, some reaction to be classified broadly as a conditioned reflex. In the simple illustration of the conditioned reflex just given, the flow of the dog's saliva in response to the familiar bell will not occur, or will be inhibited, if at the same time the dog is subjected to some other stimulus not associated with the taking of food. The higher mental reactions resembling conditioned reflexes that occur in human beings are likewise subject to inhibiting influences, of which those under the general head of *fear* are the outstanding examples.

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[14] For a more extensive discussion, see William H. Burnham, M.D., *The Normal Mind* (D. Appleton & Co., 1924).

Inhibitions in turn are subject to *inhibitions of inhibitions,* apparently in an endless chain, so that the action resulting from any set of circumstances depends upon reactions to stimuli, inhibitions, inhibitions of inhibitions and so on, in an extremely complicated manner.

In infancy the habitual reactions and conditioned reflexes are simple. As infancy merges into childhood they become more complex, beginning to deal with social relations and being judged, as to their success or failure, with more intelligence. Through childhood and adolescence they become more and more invariable as traits of the individual, and in an adult life they can be modified only with difficulty. Many actions become crystallized into *habits,* and, in consequence, are more and more skillfully performed with almost no conscious attention. There also develop what are known as *mental attitudes,* or personal tendencies or traits with respect to the feelings or emotional reactions and to the manner in which the mind is directed. These attitudes, too, tend to become habitual. Thus, in all of our affairs, from the most trivial to the most important, there enter the personally developed reactions to stimuli, associated stimuli, and multiple inhibitions of conditioned reflexes, in vast number and in almost infinite variation for each different individual; and all of these become systematized, or more or less reconciled and adjusted to each other, in habits and attitudes.

The ideal toward which mental hygiene strives is termed *integration of the personality,* meaning a harmonious blending of all of the many personal traits, of attitudes, complexes, motives, inhibitions, etc., in a well-ordered whole. *Self-realization* is another almost equivalent term. Practically, however, such integration or harmony does not attain perfection, but is marred by what are known as *conflicts.* One set of motives deeply ingrained in the personality may impel toward a certain train of conduct while another set almost equally potent may urge an opposite action. Most of these motives, it should be borne in mind, are not recognized by our conscious minds but exist as undercurrents in our subconsciousness. We hear much of *complexes,* or compelling interests containing impulses toward action that are present in the individual as peculiarities although he is unconscious of any reason for them, and may not even realize that they exist. These, in addition to our conscious and logical consideration of what is the best course to pursue, exert a powerful influence upon our decisions. Conscious and subconscious motives may conflict. There may also be conflict between two or more motives both of which are below the level of consciousness. Also there are the inhibitions, using the term in its more stereotyped sense of subconscious negative considerations, casting their weight in opposition. It is the conflicts between all of these that prevent integration or harmony.

Such conflicts, whether partially conscious or totally subconscious, are intolerable and tend inevitably to some solution or compromise. The best solution is the victory of reality and logic by seeing the truth clearly and drawing rational conclusions. But even in this fortunate event the battle leaves its scars. The unworthy motive is subjected to what is called *repression.* This means that it is conquered so far as its power to command action is concerned, but unfortunately many subconscious motives that are thus repressed into the subconscious mind continue to remain there as trouble makers, producing, either continuously or periodically, states of vague unrest. Conflicts and repressions, according to one theory, may be the cause of the abnormal sense of exhaustion in neurasthenia.

In other instances, the solution of the conflict is one which, when brought out in the light of actual fact, seems fantastic or bizarre, and constitutes an obviously abnormal condition. The commonest form of this solution of a conflict is that in which the individual, in response to a complex involving a feeling of inability to cope with his environment (inferiority complex), is unconsciously impelled to assume the rôle of invalidism. Innumerable persons who complain of symptoms strongly suggestive of physical disease are found, when it becomes possible to arrive at the actual state of affairs, to have built up their conviction that they are ill on a purely mental basis. Subconsciously, although wholly innocently so far as any conscious intention to deceive is concerned, they have argued that an apparent physical disability will be accepted as an excuse for failure, and that if they are believed to be ill they will receive sympathy and condonation of their shortcomings, instead of the harsh judgment of the literal world that they dread to face.

Some reactions of this sort have their outward expressions only in not very abnormal actions, such as temper tantrums or weepings or sullenness. But other instances are marked by more unnatural manifestations, from loss of the voice and apparent deafness and blindness up to extensive paralysis and symptoms that may bear a close resemblance to those of almost any known physical disease. The cases of this sort are those that come under the head of *hysteria*, to be described shortly. Likewise the peculiarities of *psychasthenia* and the state of irrational fear in the *anxiety neuroses* are believed to exist on a similar basis.

There are many systems of analyzing such disorders in individual cases and of treating them. As is inevitable in such a new field, the practical situation leaves much to be desired. It must be confessed that the medical profession, at least as represented by the general practitioner, has lagged behind in following the psychological advances. At the same time, the psychologists who are attempting to provide treatment have not in all cases obtained sufficient insight and perspective to deserve implicit confidence. There are many faddists who reduce the subject to absurdity. Thus, the public must often choose between physicians with little knowledge of modern psychology and psychologists without knowledge of medicine; and in some instances both fail in their service. Many psychologists, it is true, have acquired a certain grasp of medicine and a practical insight into human nature such as comes from medical practice. Also many physicians who pretend to no scientific knowledge of psychology have, nevertheless, a considerable power to understand peculiarities of personality and to exert influences favoring improvement. But, superior to the treatment of either of these alone, is treatment by a physician and a psychologist acting in cooperation, or, if it can be obtained, by a physician who has added to his medical training a training in psychology.

The principle of treatment in these mental disorders is first to analyze as deeply as possible the psychological basis of the disorder in each individual case, and then to exert influences to rectify the underlying abnormalities. To this end much can be accomplished by merely explaining the situation so that it will be seen in its true light. Even the statement of the case by the patient to the doctor and "talking it out" is a valuable form of psychotherapy. If, in addition, the physician can give an explanation and can conduct a course of training of the mental processes so as to reëducate the viewpoints or mental attitudes into a more nearly normal state, great benefit results.

Even more important than its bearing upon the treatment of abnormal states are the bearings of psychology upon their prevention. In childhood the mind is plastic, and although it is at this time that most abnormal tendencies have their beginnings they are not yet too firmly fixed to be eradicated. If in the future the principles of mental hygiene can be applied more generally to the upbringing and education of children the advantage will be incalculable.

With this theoretical introduction, we may proceed to more objective description. Although the divisions are not absolute, the psychoneuroses may be classified under four headings: (1) hysteria; (2) psychasthenia; (3) neurasthenia; and (4) the anxiety neuroses.

Hysteria.—It is popularly held that hysteria or "becoming hysterical" implies uncontrollable laughter, weeping, or other temporary emotional outbursts under conditions of excitement. It is true that such behavior does come under the head of hysteria, and perhaps is its most usual manifestation. But the disorder likewise includes many important varieties of longer duration which may simulate grave bodily and mental diseases. Long-continued paralyses of arms or legs, inability to speak, deafness, blindness, loss of sensation, convulsions similar to those of epilepsy, and changes of personality resembling insanity may all be merely manifestations of hysteria. So-called trances, amnesia or temporary loss of memory, and the variations of temperament and behavior called multiple personality, belong in this class.

Hysteria, according to the conception now most generally held, apparently represents a conflict between the conscious rational mind and the subconscious mind resulting in a lack of control over acts and emotions, by morbid self-consciousness, by exaggeration of the effect of sensory impressions, or by simulation of various disorders. Thus, for instance, when an arm or a leg is in a state of paralysis due to hysteria, the subconscious mental processes have apparently become dominant to the extent of preventing the conscious will from moving the arm or leg. In some instances, by various forms of analysis, a definite reason is traceable for this unwillingness of the subconscious mind to use the arm or the leg. The excitements and fears connected with war have resulted in many disturbances of this kind. True hysterical symptoms are not due to conscious and willful malingering although the differentiation is sometimes difficult.

Psychasthenia.—Under the term psychasthenia are grouped the curious, troublesome, and seemingly unnecessary impulses, inhibitions, and fears which in many persons are distinct handicaps. Abnormal difficulty in making decisions (*folie du doute*), impulses to go back repeatedly to see whether a door has been closed or the lights turned out, imperative impulses to touch every post of a fence, unreasonable fear of open places or other perfectly safe situations, and exaggerations of improbable dangers are characteristic. The individual manifestation of this disorder very probably depends upon impressions of early childhood. The chief difficulty, however, seems to be an inherent abnormality of the personality becoming evident in early years and continuing to a more or less pronounced degree throughout life.

Neurasthenia.—The term neurasthenia is commonly used, for lack of a more appropriate one, to describe the presence of a certain combination of ill feelings without organic basis or origin for its existence. The symptoms commonly denoted by neurasthenia are fundamentally two, with many others added. The first of these is complaint of an unnatural sense of fatigue; the second is anxiety or apprehension as to the presence of physical disease. While these are still classified as nervous disorders, since reactions of the nervous system are certainly a factor, there are many indications that the symptom of fatigue may ultimately be shown to have a basis in a still unknown physical disorder, whether of the internal secretions, of nutrition or of metabolism.

This state of abnormal fatigue with nervousness, also called "irritable weakness," is very widespread, and seems to be increasingly prevalent as civilization becomes more complex and standardized. It manifests itself in all grades of severity, from the slighter degrees of morning fatigue, which are present probably in the majority of all persons, to the more conspicuous states in which there is total incapacity for all usefulness or enjoyment. Combined with the sense of fatigue there is a peculiarity of the mental attitude, which is difficult to describe but which is well recognized by all who come in contact with neurasthenic persons. The mind is keen, usually somewhat overactive, and has a peculiar faculty of reaching irrational or mistaken conclusions in an apparently logical manner. There is apt to be an attitude of querulousness, sensitiveness, and irritability, all of which are disagreeable to those with whom the person is closely associated. Added to this, in many instances, there is constant worry over misfortunes which in reality are unlikely, and particularly worry, often amounting to firm conviction, that some serious physical disease is present. Extreme pessimism is characteristic. Many investigators of mental disorders are inclined to connect these apprehensions and beliefs with inability, real or supposed, to accomplish satisfactorily the tasks of daily life, or to cope successfully with environment. They find reason to believe that failure in the general affairs of life produces a dissatisfaction which unconsciously seeks an outlet, and creates a more or less unconscious desire that physical disease may be found as an excuse. Such analysis very possibly strikes the truth with regard to the neurasthenic's false conclusions. It may be that the wear and tear involved in worrying and in unprofitable thought are the explanation of the feelings of maladjustment, but it is still possible that the state of exhaustion may have its basis in some still unknown physical disorder.

The tendency to neurasthenia seems to be more or less inherited, along with other traits of personality. To a certain extent it is familial and racial. Radical changes or particular circumstances of environment frequently aggravate the condition, and may be classified under the general head of poor adaptation to the surroundings. Particularly common in our present civilization is neurasthenia developing from idleness and lack of serious purpose following the sudden acquisition of wealth. Mental concentration and worry connected with difficult affairs sometimes lead to nervous breakdown, but on the whole the most fertile source seems to be the purposeless brooding and worrying which goes on for lack of appropriate routine duties and definite objectives.

Complaints based fundamentally upon neurasthenia and not upon physical disease form a large proportion of all symptoms which a doctor is called upon to treat, and are also the most difficult to improve. It is usually easy to demonstrate that the disease which the patient fears—whether diabetes, nephritis, appendicitis, or other disorder—is not present. On the other hand, mere assurance accomplishes little. Other symptoms are complained of in endless succession. What is really necessary is complete reconstruction of the patient's habits of life and of all his trains of thought to form a better-ordered whole, more consistent with the best self-realization. Obviously this is a large task, both for the doctor and for the patient. In the more serious instances it can be effected, if at all, only by residence in a sanitarium where the daily life is systematized for this purpose. In the less serious cases something may be accomplished by explanation tending to establish a more wholesome viewpoint, and a better adjustment of the mode of living. Routine employment involving little planning seems to be most favorable to satisfactory adjustment. For the fatigue symptoms and also for general restlessness, systematic physical training is an important resource.[15] For morbid philosophizing and brooding, a recreational hobby or some form of handwork (*occupational therapy*) is useful. Still more effectual in integrating the personality, or making life worth while by giving it a dominant purpose, is the development of new interests and ideals, sometimes through appeals to self-respect, to duty, or to religion,[16] especially if these can lead to some worth-while form of service[17] which will be performed with enthusiasm.

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[15] Where confusion in the daily life is a factor, assistance in planning it more systematically, and providing recreation and diversion, with exercise and rest in proper balance, are of value.

Persons who recognize in themselves a tendency to neurasthenia, which most people have in some degree, will do well to study themselves impersonally and to determine seriously whether they are managing their lives prudently. Facing reality with a clear vision and in true perspective, resisting all conscious or unconscious temptations to distort the facts either favorably or unfavorably, often points the way to improvement. If the difficulty is pronounced or seems to be increasing, there is great advantage in discussing it with a doctor. This doctor need not necessarily be a specialist in such disorders, since all physicians have experience with neurasthenia and frequently the one who knows the patient and his family is well qualified to advise. If in his opinion the case demands it, he will recommend a specialist who may be consulted with confidence. At the same time persons with neurasthenia should recognize that the condition is one in which they must take themselves in hand, and not one in which a cure can be effected by medicines or pills, or by any other passive treatment which is accepted without supplying active coöperation. In all ordinary instances, improvement in hygiene and in the system of daily life, assurance by a doctor's examination that there is no physical disease, and the cultivation of a cheerful and rational attitude are sufficient.

This last object is most strongly favored by the development of a sense of humor—a powerful corrective of that false sense of values called "taking one's self too seriously." Laughter is a potent antidote for mental depression.[18]

[16] Janet, a pioneer in the study of the psychoneuroses, made the statement: "A truly religious person does not become neurotic," a truth generally confirmed by medical experience.

[17] A task, or some appropriate piece of work that can be performed with a sense of success, has been stressed as an important psychotherapeutic measure.

[18] See James J. Walsh, M.D., *Laughter and Health* (D. Appleton & Co., 1928).

CHAPTER XXXII

SURGERY

Development of Modern Surgery.—The past fifty years represents the most revolutionary advance in the history of the healing art. Preventive medicine has probably saved more lives, and the discovery of the practical value of the various antitoxins is doubtless a more advanced application of scientific knowledge. But the benefit conferred upon humanity by the discovery of the germ origin of disease and its adaptation to surgery is incalculable. In medical practice a great change has been effected by the introduction of modern surgical methods which have enabled man to interfere actively with unfavorable processes of nature in a great variety of abnormal conditions, and to effect cures that nature alone could not accomplish.

Long ago, surgery was practically confined to the treatment of wounds and injuries and to the drainage of abscesses that lay immediately beneath the body surface. Some operations were performed, notably "cutting for stone" (of the bladder), but these were few and crude. The slight and generally useless procedure of "blood-letting" was prevalent, but otherwise the work of the surgeon, who was also the barber, consisted chiefly of the treatment of wounds. "We dress the wound, God heals it" was the reverent dictum of the Middle Ages—indicating that then, as now, the surgical treatment of wounds was merely a matter of aiding nature. Modern surgery, however, has assumed a more active rôle, and the surgeon of today might add: "I also make wounds, to effect purposes which nature is unable to accomplish; and by precautionary methods bacterial infection is avoided and nature is enabled to heal these wounds so that man survives and is relieved of his diseases."

It should be remembered that in earlier times operations were performed without the administration of ether or chloroform, so that the field of surgery was necessarily limited. Anæsthesia was discovered less than a hundred years ago, and it was this advance in technic that paved the way for surgical progress. In the beginning, however, and even throughout the period of our Civil War, the use of anæsthetics, chiefly ether, was regarded merely as a measure to diminish the suffering incidental to surgery, rather than as a means for its development and for the greater efficacy of its methods.

Following the early bacteriological discoveries of Pasteur, it remained for Lister to demonstrate in England, in 1870, that if, by the use of antiseptics, bacteria were prevented from invading the field of operation, the incision would heal promptly, without the inflammation and pus formation which had been considered inevitable up to that time and had often proved fatal.

This really opened the door for modern surgery, since it then became possible for the first time to make incisions without grave danger of death from infection. Moreover, it became possible to perform abdominal operations. Before Lister's discovery incision of the abdomen was expected to result in fatal, generalized peritonitis; but with this bugbear largely removed, many operations for the relief of various abdominal disorders were attempted and successfully performed.

Since Lister's day *asepsis* has supplanted *antisepsis*. Thus, in surgical technic today, all instruments, rubber gloves, cotton "sponges," and everything that comes in contact with the wound is sterilized (that is, rendered *aseptic* or free from living bacteria) by heat before operation, chemical antiseptics being used comparatively little. This, however, represents only an elaboration of Lister's original ideas. The principle of preventing bacteria from entering operative wounds, which is the basis of all modern surgery, must be credited to Lister, or, indeed to Pasteur, the "Father of Bacteriology," to whom Lister was indebted.

The next step in surgical advance related to the evolution of the many different operations. After the technic of incising wounds reached a point which minimized prohibitive suffering during and after operation, at the same time insuring prompt and safe healing, the real development of surgery became possible, and the combined experience and investigations of countless pioneers in this field have contributed to its steady progress. The differentiation and surgical treatment of appendicitis[1] was one noteworthy achievement illustrative of many others. In many disorders for which medical treatment offers little or nothing in the way of curative measures, from ovarian cysts and tumors or appendicitis and gallstones to disease of the thyroid gland, modern surgery has resulted in cures or in such marked relief of symptoms that it is recognized as the only effectual procedure.

The Field of Surgery.—The conditions in which treatment by surgery is indicated at the present time are: (1) injuries of all parts of the body; (2) accessible local inflammations, particularly those in which suppuration is present; (3) the removal of external tumors, or, as surgical skill has increased, of those connected with internal organs; (4) the alteration or repair of internal structures which have been so impaired by disease as to render them defective or generally inefficient in carrying on the body processes necessary to growth and health. As may be readily understood, the last mentioned group is the most important, since it is in this field that surgery has been the greatest boon to mankind.

WOUNDS

Wounds are generally understood to be injuries involving division of the body surface, penetrating to a variable depth.

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[1] See section on Appendicitis in chapter entitled Diseases and Disorders of the Digestive System, p. 313.

In addition to injury of the skin and underlying muscle tissue, the bones or internal organs may participate. Serious wounds involve surgical shock, which has been described. They also result in bleeding, greater or less according to the extent of the division of blood-vessels. Less immediate but of equal importance is the possibility of bacterial infection. Any wound not immediately fatal from shock or hemorrhage has a strong natural tendency to heal; but prompt healing is conditional upon the absence of infection. If this is present it not only retards or prevents healing of the wound, but it may cause death.

In dealing with all wounds every possible means to avoid infection must be utilized. In many instances the object which caused the wound has been dirty and has left within the opening some foreign material containing bacteria. An equally probable source of infection is the unskillful or improper treatment of wounds either by manipulation with non-sterile instruments and cloths, or by handling with unwashed fingers.

Checking of bleeding is the first step in the treatment of most wounds. Unless this is serious, it is better not to permit non-sterile handkerchiefs or anything else to come in contact with the wound; but if the bleeding is serious, firm pressure should be made upon it with as clean a handkerchief as may be obtained, even at the risk of infection. If an extremity is wounded, it should be elevated above the rest of the body.

If surgical facilities are available, the second stage in treating a wound is the sterilization of the surrounding skin with tincture of iodine, the removal of all visible dirt with sterile instruments, and the application of a sterile or mildly antiseptic solution to the exposed tissue. If this cannot be done immediately, it is best to paint the entire wound with iodine. After the wound is cleansed, if the skin can be brought together by stitches, these are placed and tied, using sterile material. Finally, a dressing of sterile gauze is applied.

If redness and swelling do not appear in the following days, it is evident that the wound is healing without suppuration. If, on the other hand, redness, swelling, and pain develop, suppuration is present and the stitches should be removed that the wound may open and discharge its pus. In that event healing will be delayed until the suppuration has gradually subsided.

Wounds of the scalp or forehead are frequent, but ordinarily heal without serious infections.

Wounds of the hands and feet, even pin-pricks, sometimes result in infection out of all proportion to their size. Infected wounds of a finger may cause intense inflammation of the hand extending to the arm, and pus formation in the deeper structures of the hand and forearm, constituting an extremely serious illness.

Bullet Wounds.—Wounds which involve deep penetration with only a small point of entrance are particularly susceptible to two dangers not usually present in wider and more superficial cuts, due to the fact that dirty material, such as earth or bits of clothing, has been carried deep beneath the surface, and has had no opportunity to discharge itself through the point of entrance. Such wounds may result in (1) *tetanus* or *lockjaw,* or (2) *gas bacillus infection.*

Tetanus or *lockjaw,* the bacilli of which are present in moist earth and frequently in the wadding of cartridges, is a particular complication of bullet wounds and wounds caused by rusty implements. It may be prevented by the prompt injection of tetanus antitoxin.

The so-called *gas bacillus infection* is the most serious danger in war wounds, and particularly occurs in those involving severe bruises of the deep tissues about the wound; especially if cloth or dirt has been carried in with the bullet. If swelling develops in the days following the infliction of a wound, free opening is necessary even though the wound of the bullet may seem small; and if, despite this treatment, gas bacillus infection makes headway in a wound of the arm or leg, amputation may become necessary to save life.

Here it may be mentioned that it is unwise for the layman to permit himself to be influenced by fiction writers who have so notoriously garbled the subject of amputation. When gas bacillus infection is present, it is well to be guided by the advice of an experienced surgeon. If amputation is recommended, and the patient takes it upon himself to risk probable death in the improbable hope of surviving without loss of a limb, the outcome will usually be fatal.

FRACTURES OR BROKEN BONES

Bones may be broken or crushed by blows, falls, and other violence. The immediate result is that the broken bone loses its previous rigidity, so that motion is possible at the point of the break. In the course of weeks, scar tissue forms as in other processes of repair, which have been described. By deposits of lime salts this scar tissue is subsequently transformed into new bone, so that ultimately the broken ends are firmly united. After fracture, union occurs in whatever position the broken ends remain, and more or less permanent deformity may result according to the extent to which this healing position differs from the previous normal one. Thus, in some fractures which have healed without skilled treatment, an arm or leg may be severely bent or shortened. Therefore, the first object of treatment is prompt, exact apposition of the fragments and maintenance of such apposition by means of splints or other appliances. The procedure of apposing the fragments is called *setting*. It is usually performed under ether and guided whenever possible by the X-ray. Individual cases differ greatly in the result. In many instances it is impossible to make accurate or exact apposition. In most of these, even though the X-ray shows that the broken ends do not meet quite perfectly, the healing process finally makes a satisfactory adjustment. There are fractures, however, in which it is necessary to operate by cutting down upon the bone in order to improve the position of the fragments, and sometimes to unite them by plates, wiring, or other fastening methods.

In first-aid treatment, no attempt should be made to use the fractured bone. This is extremely important, for if a person with a broken ankle is permitted to stand the resulting displacement may be much worse. Some sort of splint should be applied until the part can be examined by a surgeon.

Compound Fractures.—Compound fractures are those combined with a wound of the body surface, the break therefore being in communication with an open wound, thus constituting a possibility of infection which may involve danger to life, and in any event is unfavorable to prompt union of bones. Sometimes a compound fracture is the result of a simple one in which sharp fragments of a bone have penetrated the skin from within outward. Others are the result of wounds from without, such as bullet wounds or those due to other hard objects.

Some of the most frequent fractures, notably those of the wrist and of the fibula at the outer side of the ankle, are not always promptly differentiated, and, being treated as simple sprains, may heal with an unnecessary degree of deformity. Supposed sprains of the wrist or of the ankle should be examined by a surgeon and usually by X-ray.

Ordinarily, fractures of long bones are obvious. Fractures of deep-lying bones, like those of the pelvis and the vertebræ, are detected more readily by X-ray than by manual examination. Fractures of the skull may be detected only by the X-ray. Bleeding from the ears after an injury to the head is suggestive of fracture of the skull. In most instances of such deep-lying fractures there is little to be done save to impose complete bodily rest upon the patient until healing occurs. The deformity that results is usually not as great as anticipated.

SPRAINS

Sprains of joints are ruptures or tears of the fibrous ligaments which hold the ends of the bones together at the joint, and are caused by strain when the joint is forced to bend further than it should. The result is pain and swelling from temporary inflammation, preventing use of the joint. The chief reason for regarding sprains seriously is that sometimes, particularly in the wrist and in the ankle, there is an unrecognized fracture. Otherwise, if motion of the joint is prevented so that there is no strain on the torn ligament, perfect healing may result.

DISLOCATIONS

In a dislocation of a joint, the fibrous ligaments connecting and enclosing the ends of the two bones at the joint are torn apart so that the end of one bone projects through the opening, producing an obvious distortion of the joint and inability to use it. Occasionally, both fracture and dislocation are caused by the same injury. Simple dislocations are reduced by special manipulations by means of which the bones are forced to return to their normal relation. If subsequent motion of the joint is prevented, by a splint or bandage, healing of the torn ligaments occurs as in a simple sprain.

Of the large joints, dislocation of the shoulder is the most frequent, although the elbow and the hip are also subject to dislocation. In playing baseball the finger joints are often dislocated, requiring a pull to snap them back into normal position.

BURNS, FROSTBITE, AND EFFECTS OF CHEMICAL CAUSTICS

The effects upon the body surface of heat, of freezing, of electricity and X-rays, and of caustic chemicals are all practically the same in that they cause local death of skin and perhaps of underlying tissue. This dead or gangrenous tissue must eventually separate itself from the body; healing then occurs by the formation of scar tissue and of new skin.

Scalds from boiling liquids are usually extensive but superficial, while burns by fire, hot iron, or chemicals are ordinarily deeper. Even scalds, however, produce scars.

Extensive burns also produce generalized effects involving danger to life. Not only is there surgical shock, but fever and other serious symptoms due to absorption by the body of substances created by the burn. Infection may likewise occur; the treatment therefore includes preventive measures.

In such burns or scalds, the first step in treatment is alleviation of pain and measures to relieve surgical shock. The treatment which, in recent years, has yielded the best results consists of covering the body surface with a layer of specially prepared melted paraffin so as to exclude air. Another treatment is free exposure of the burn to the air in a warm room, no dressing being applied. For extensive burns, both of these methods have proved far superior to treatment with oils and ointments.

TREATMENT OF SHOCK FROM INJURIES

The emergency treatment of surgical shock, the general symptoms of which have been described,[2] consists of: (1) placing the patient flat on the back with the head low, in order to favor circulation in the brain; (2) the application of external heat, as by hot blankets, in a warm room; (3) administration of hot, sweetened drinks, preferably black coffee or tea; and (4) relief of pain in any possible way.

The doctor's treatment will include measures to favor all of these objects. In addition, drugs known as stimulants are utilized in such conditions, but only as prescribed by the physician, as there is more likelihood of harm than of benefit if they are administered at random by untrained individuals. Whisky and brandy, in amounts large enough to produce effects, are now generally considered inadvisable, but either of them, or aromatic spirits of ammonia in water, in teaspoonful doses may be classed as minor stimulant measures.

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[2] See section on Shock from Injuries in chapter entitled Pathological Physiology, or General Reactions to Disease, p. 154.

INJURIES TO THE HEAD

Blows upon the head derive their medical significance from their possible effects upon the brain. Wounds of the scalp are relatively trivial matters. Fractures of the skull, serious as they may be, are chiefly to be considered in their effects upon the brain.

A heavy blow on the head, whether or not a scalp wound or a fracture results, produces unconsciousness. This may be either momentary or of longer duration, depending largely upon the resulting injury within the skull. Unconsciousness of short duration, that is, an hour or so, with subsequent progressive recovery within the next twenty-four hours and no evidence of serious injury, is known as *cerebral concussion* or *cerebral contusion.* In other instances, however, the unconsciousness may persist longer or there may be a relapse into deeper unconsciousness after consciousness is once regained. In these cases there may be internal bleeding from rupture of blood-vessels within the skull, causing pressure upon the brain. This may occur either with or without fracture of the skull. The condition is a critical one, since continuance of abnormal intracranial pressure may be fatal or may demand operative procedure to relieve the pressure and so save life.

After injuries to the head, even those in which there is no fracture or evidence of internal structural impairment, there may be complaint of headache, of dizziness, and of other disagreeable symptoms for months or longer. As a rule, however, these gradually subside.

INJURIES TO THE SPINE

The most serious injuries to the vertebral column are those involving the spinal cord, with consequent paralysis and loss of sensation of parts of the body below the point of injury. Impairment of the spinal cord in the neck paralyzes the breathing and is therefore fatal, but if the injury is lower in the cord the patient may survive. Skilled surgical treatment is essential, since in some instances fractured and dislocated bones producing pressure symptoms may be removed and the spinal cord recover its function. Unskilled manipulations may readily make matters worse. The injured person should be moved as little as possible.

Minor injuries to the lower spine are curiously apt to cause long continued complaint of pain, largely of mental origin. The condition known as *railway spine,* after jolting in an accident, continues while a lawsuit is pending but recovers after a settlement. Particularly in women, backache is often the result of mental unhappiness and not of physical disease. Backache is likewise perhaps the most frequent complaint in soldiers attempting to obtain discharge on grounds of disability.

INJURIES TO THE CHEST

Blows upon the chest frequently cause fractures of ribs. These cause pain on breathing but as a rule heal satisfactorily.

Bullet and stab wounds involving the heart are usually fatal, while those in which there is injury only to the lungs result in recovery in the majority of instances. Wounds of the lung cause bleeding into the pleural cavity, with immediate symptoms of shock, hemorrhage, and breathlessness; but subsequent infection producing empyema[3] is the chief danger. If infection does not occur nature effects recovery.

WOUNDS OF THE ABDOMEN

Violent blows upon the abdomen may rupture the stomach or intestine causing acute peritonitis. Bullet and stab wounds can scarcely enter the abdomen without perforating the stomach or intestine. Therefore, in cases in which peritonitis is imminent prompt operations are undertaken to close all perforations.

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[3] See section on Empyema in chapter entitled Diseases of the Lungs and Respiratory Tract, p. 299.

OPERATIONS FOR CONDITIONS OTHER THAN INJURIES

It was previously explained that modern surgery is based upon the power to cut, adjust, reconstruct, and sew the body with relatively little danger. By means of this advance many pathological conditions heretofore irremediable may now be relieved. Surgery is indicated in a variety of diseases, notably: (1) inflammations and their results, (2) tumors, (3) correction of deformities. In addition, there are many special operations difficult to classify.

The chief disorders susceptible of surgical treatment may be enumerated, from the head downward, as follows:

Tumors of the brain are in some instances removable. *Cancer of the lip* and *of the tongue* may be treated surgically. *Adenoids* and *enlarged tonsils*[4] frequently require removal. Within recent years the *thyroid gland* has been operated upon with decidedly increasing success. *Deep abscesses of the neck* demand surgical drainage. *Tuberculous glands of the neck* are sometimes best treated by surgery. In some varieties of *tumors* and *cysts of the neck* operations are advisable.

Empyema[5] rarely recovers without surgical drainage, and this is likewise true of *pus-forming pericardial inflammation. Subphrenic abscess* is a comparatively rare disease in which a localized collection of pus exists beneath the undersurface of the diaphragm. It is much like empyema, and should be similarly treated.

The *female breast* may be the site of *abscesses,* particularly during lactation. It is also susceptible to cancer and other *tumors.* Any mass in a breast demands prompt medical examination, since a large proportion result in cancer. If operated in its early stages *mammary cancer* is usually permanently curable, but if neglected it may become a hopeless surgical risk while the patient is still unconscious of the danger.

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[4] See sections on Adenoids and Diseases of the Tonsils in chapter entitled Diseases of the Nose and Throat, p. 445.

[5] See section on Empyema in chapter entitled Diseases of the Lungs and Respiratory Tract, p. 299.

The abdomen is the particular field of modern surgery. As already mentioned, the most frequent abdominal operations are the removal of the appendix for *appendicitis* and of the *gallbladder* for inflammation or *gallstones*. Operations which are always imperative are those for *intestinal obstruction,* for *perforation of the stomach or intestine,* and for *pancreatitis. Abscesses in or about the kidney* require surgical drainage. *Stone in the kidney, ureter, or bladder* is usually treated operatively. Many *abdominal tumors* may be removed surgically. Tumors and cysts of the female genital organs, particularly *fibroids* and *cancer of the uterus* as well as *ovarian cysts and tumors* usually require surgical removal, and frequently demand it. The decision in such cases may safely be left to a surgeon of wide experience. *Hernia* or rupture is a frequent abnormality, especially in men. It originates from a weakness or imperfect closure of the abdominal wall, usually in the groin, as a result of which a coil of intestine bulges through the fibers and muscles forming the abdominal wall. Thus, an individual with a rupture is conscious of a swelling which appears from time to time under the skin in the groin, particularly when coughing or upon exertion incidental to heavy lifting. Trusses and various apparatus for the treatment of ruptures are extensively advertised, but the only satisfactory treatment is surgical repair.

Enlargement of the prostate gland in elderly men is a disorder for the relief of which modern surgery has accomplished much. This enlargement, accompanied by hardening, is a change which occurs to some degree in every man during later life. In the majority of instances it is harmless, save for the annoyance of passing urine at some time during the night; but in numerous cases the symptoms may be more pronounced, involving serious difficulty and discomfort in voiding urine. There may even be complete inability to empty the bladder, which demands immediate relief by the insertion of a tubular instrument known as a catheter, carefully sterilized.

In recent years the surgical technic for removal of the prostate gland has been so much improved that the operation is almost invariably successful in relieving prostatic disorders.

Cancer of the prostate gland causes similar symptoms. While something may be done to diminish discomfort and prolong life, complete and permanent removal of the tumor is practically impossible.

Certain disorders within the scrotum should be briefly mentioned.

Varicocele is an enlargement of the veins within the scrotum where they are palpable as a tangled mass of coils. The condition is probably a peculiarity of development rather than an acquired disease, and may involve some aching or discomfort. Among physicians it is regarded chiefly as a cause of unwarranted apprehension and not as a disorder of serious importance. The enlarged veins are surgically removable, but nevertheless the discomfort and nervousness incidental to the condition frequently remain unimproved. Ordinarily, a well-fitting support and the cultivation of patience are the most effective treatment.

Hydrocele is a sac of clear fluid which may form within the scrotum, and sometimes attain considerable size. If the sac is sufficiently large to be annoying, it may be permanently removed by surgery.

Epididymitis is an inflammation of one of the structures within the scrotum beside the testicle, resulting usually in fever and severe pain. Many cases are the result of gonorrhea. In the milder instances spontaneous recovery occurs but the more severe forms require surgical drainage. *Tuberculous epididymitis* produces a chronic inflammation of the same structure, for which surgical removal is usually recommended.

Injuries to the testicle are not infrequent and vary greatly in their severity. In serious ones, with great swelling and internal bleeding, operative procedure is indicated, but slight injuries usually heal spontaneously.

Tumors sometimes appear within the scrotum and, as they may be malignant, medical advice should be sought as soon as any abnormal growth is noticed.

CHAPTER XXXIII

ORTHOPEDIC SURGERY: DISEASES OF THE BONES, JOINTS, AND MUSCLES

This is an important branch of surgery, embracing the correction and repair of the skeletal system, by operative procedures and particularly by mechanical measures including corrective apparatus.

The word orthopedic, sometimes spelled orthopædic, is frequently understood by the layman to have some connection with feet, as the syllable *ped* in certain other words means foot. It is therefore generally assumed that the orthopedic surgeon is a foot specialist, not clearly distinguishable from the chiropodist. This mistaken notion is reinforced by the fact that shoe manufacturers are given to advertising their wares as designed to meet orthopedic requirements. But the penultimate syllable is derived from the Greek root *paid*, meaning child (as in the words pedagogue and pediatrics) and not from the root *ped* meaning foot. By derivation, the word orthopedics denotes the science of making children straight.

Formerly orthopedic surgery was concerned chiefly with the prevention and correction of deformities in children, but it has been gradually modified until it now includes the similar treatment of adults. Like some other scientific terms in medicine, it is no longer precisely descriptive.

The actual province of this specialty is not well defined, since there is some overlapping with both general surgery and internal medicine. Unquestionably it includes all deformities of the bones and joints present from birth, and all those which have developed or threaten to develop either in childhood or later life, from any cause. Among the diseases most likely to result in deformities, or imperfect coördination of the body framework are: (1) rickets in its later stages; (2) tuberculosis of bones and joints; (3) chronic arthritis, both atrophic and hypertrophic; and (4) infantile paralysis. While most of these are, to an extent, medical in their nature, it is generally accepted that they are best treated by an orthopedic surgeon, or at least that it is desirable that one should direct the mechanical side of their treatment.

There are likewise numerous ill-defined conditions producing pains referable to the bones, joints, or muscles, but in which exact diagnosis is difficult or impossible. In such instances an orthopedic surgeon is best qualified to determine the nature of the disorder.

Poor posture, curvatures of the spine, and disorders of the feet are orthopedic conditions.

Injuries such as sprains, dislocations, and fractures, as well as *osteomyelitis,* remain on the border line between general and orthopedic surgery, but there is an increasing tendency in medicine to transfer to the latter the more serious and difficult cases.

DISEASES WHICH THE LAITY DESIGNATE "RHEUMATISM"

The term "rheumatism" has been used so vaguely that it is not susceptible of exact definition save to remark that it implies local pain, usually in the skeletal system. Pains designated as "rheumatic" originate in joints, bursæ,[1] muscles, bones, or nerves. Thus the term rheumatism includes: (1) diseases of joints, known as *arthritis;* (2) inflammations of bursæ or *bursitis;* (3) diseases of muscles, known as *myositis* or *myalgia,* as represented by *lumbago;* (4) diseases of bones, particularly that variety known as *periostitis;* and (5) inflammation of nerves, known as *neuritis.* Aside from these conditions of inflammatory origin, similar symptoms may arise from injuries or strains involving these same structures. The

[1] See section on Inflammations of the Bursæ in this chapter, p. 401.

situation is complicated by the fact that there are many aches and pains not completely traceable to any definite structures, and by the further fact that many people have discomforts which are aggravated by concentration and apprehension tinged by fancy.

DISEASES OF JOINTS

Rheumatic fever has already been discussed. Gonorrheal arthritis is considered under the heading of gonorrhea. Tuberculous arthritis, resulting in stiffness and deformity rather than in pain, is described separately. Sprains, strains, and dislocations of mechanical origin have been previously mentioned.[2] There remain two important forms of arthritis which are of frequent occurrence and cause much suffering and disability: (1) *atrophic* or *rheumatoid arthritis,* and (2) *hypertrophic* or *osteoarthritis.* Both of these may be classified as chronic diseases.

Atrophic or Rheumatoid Arthritis.—This is the disease ordinarily and most properly referred to as chronic rheumatism. In its worst form it affects many joints, with pain and swelling continuing for a year or more until the inflammation finally subsides. More or less deformity of the joints results, and sometimes permanent stiffness. Cases vary greatly in severity; in some instances, the only manifestation may be chronic swelling and pain in a single small joint as in a finger, while in others involvement of many large joints may occur. However, the disease of the joints is always the same, and differs from that of acute rheumatic fever in that the disorder in each joint follows a sluggish course for months or years, instead of subsiding within a week or less.

In all of the more severe cases, numerous joints are involved, most frequently the knees, knuckles, and wrists. There is swelling of the tissues about the joints, with some inflammation and heat, and with pain on motion. X-ray examination shows more or less destruction of the bones and cartilages of the joint. Pus formation does not occur, but there is an ultimate tendency to permanent union of the bones which meet in the joint.

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[2] See sections on Sprains and Dislocations in chapter entitled Surgery, p. 387.

When the hands have been attacked, an outward bending of all the fingers is characteristic.

The cause of this type of chronic arthritis is one of the chief unsolved questions in medicine, because of the large number of persons affected. No specific bacterial infection has yet been definitely proved, although recent efforts along this line would seem to indicate its existence. That the disease of the joints is due to poisonous substances of bacterial origin, produced by infections in the body elsewhere than in the joints, is a prevalent theory; and in some instances the removal of chronically infected tonsils or tooth-roots has been followed by cessation of arthritic symptoms. There is likewise reason to believe that abnormal bacterial growth in the intestine may be a causative factor in some cases. However, the entire matter is still obscure, and consequently no directly preventive or curative measures are known.

The treatment as at present conducted includes: (1) removal of any foci of infection that may be present; (2) thorough daily evacuation of the bowels; (3) certain regulation of the diet including a restriction of carbohydrate intake; and (4) local treatment of the affected joints. There are likewise numerous particular methods of treatment, all of which are as yet in the experimental stage. Local treatment of the joints includes such measures as exposure to heat, massage, and passive manipulation. In its most painful stage the joint may require a splint for comfort, but experience has demonstrated that if a joint is moved in spite of the disease, it is more likely to retain its usefulness when the disorder finally subsides. In some joints it becomes obvious that permanent rigidity will be inevitable; in that event, the physician usually endeavors to place the part affected in such a position as to insure some usefulness and the slightest possible inconvenience. This may be achieved by the use of splints or other apparatus.

Various drugs are of service for temporary relief of pain. Some experiments are being conducted with particular drugs in the hope of securing more effectual results; but as yet no form of drug therapy is known which is at all comparable with the salicylate treatment of rheumatic fever.

Hypertrophic or Osteo-Arthritis.—This type of joint disorder manifests itself in later life and may be classified, not as an inflammatory process, but as an abnormal growth of bony deposits in the region of joints. The onset is extremely gradual, although the more marked symptoms may begin rather suddenly following some unusual exertion, or exposure to cold and dampness. The vertebræ and the hip joints are generally affected, but X-ray examinations usually reveal more or less generalized bony changes throughout the joints of the body. A frequent manifestation of this disease, familiar to most readers, is an enlargement of the terminal joints of all the fingers—an alteration usually but mistakenly designated as "gouty."

The chief symptoms are limited motion of the joints most affected, with more or less pain when it is attempted; but the pain and the disability which result are never so pronounced as in the more severe cases of atrophic arthritis. Often there are associated pains which seem to involve parts of the body other than joints. Thus, hypertrophic arthritis of the vertebræ may cause pain referable to the front of the chest and abdomen. This is because the nerves emerging from the spinal cord and leading to the front of the body have become irritated by the bony changes about their points of emergence.

The cause of this form of arthritis is likewise unknown. In fact, it is even more obscure than that of atrophic arthritis, since there is little reason to relate it to infections of the tonsils or tooth-roots, or to abnormal processes in the intestine.

The keynote in treatment is protection of the affected joints by rest, and apparatus and appliances that insure immobilization. The symptoms usually improve with prevention or limitation of movement. External heat and careful massage may be of some benefit. However, some permanent impairment of joint function usually results.

Disorders of the Knees.—Of all joints of the body the knees are most subjected to abuse and least capable of enduring it. Apart from single injuries such as blows, wrenches, or sprains, there are many forms of occupational and recreational activity in which the knees are often overtaxed. Stair-climbing, carrying heavy weights, jumping from a height, and some forms of dancing produce pressure upon the joint structures as well as marked tension or strain of the muscles at their attachments about the knee. Poor posture and the unnatural ways of walking that result from unsuitable shoes may affect the knees.

Such repeated abuse without any single severe injury is capable of inducing abnormal conditions in the joint, particularly roughening of its lining membrane, a disorder known as *villous arthritis*. The minor grades are frequent, but cause practically no symptoms save creaking or cracking in the joint. However, there may be intermittent stitchlike pains and sometimes there results a mild inflammation with swelling, designated as "water on the knee."

When treatment is necessary its chief object is to limit the use of the joint, usually by some form of bandage.

Other internal derangements of the knee occur which may cause sudden, painful locking of the joint in walking. Intra-articular displaced structures become pinched between the moving surfaces, preventing further motion. When this occurs repeatedly it is a great handicap. In many instances, orthopedic operations involving the opening of the joint and the removal or readjustment of the affected parts have been completely curative and have the advantage that less time is lost than under nonoperative treatment.

INFLAMMATIONS OF THE BURSÆ

A *bursa* resembles a joint in that it is a hollow space or empty sac lined with smooth, slippery membrane, the purpose of which is to facilitate motion with a minimum of friction. But instead of being placed between bones, a bursa is located wherever muscle attachments move over bone, or where there is friction between bone and the body surface. In health these bursæ act so quietly that their existence is not evident, but there are a great number of them in the body structure, particularly about the joints, more than a thousand having been described. Bursæ are subject to inflammations, not only in consequence of disease, as in arthritis, but as a result of injury or strains. Those particularly liable to inflammation and easily recognized are: (1) the *subdeltoid bursa,* situated on the outer side of the upper arm just below the shoulder; (2) the *prepatellar bursa* on the kneecap, inflammation of which is called housemaid's knee; (3) a bursa over the joint of the elbow, inflammation of which is known as miner's elbow; (4) a bursa to the inner side of the great toe joint, inflammation of which is the familiar bunion.

Tennis elbow is a common form of bursitis, and may be used as an illustration of bursitis in general giving rise to somewhat obscure, troublesome pains. It is a disease of a small bursa situated close below and behind the elbow-joint. It was first demonstrated by a surgeon who, having the disorder, caused his elbow to be operated upon without taking an anæsthetic so that he might examine the exposed structures. Sudden forceful rotations of the forearm in tennis playing result in unaccustomed friction upon this bursa and cause inflammation. When once produced, this inflammation continues obstinately and indefinitely. The pain seems to involve a large part of the upper portion of the forearm, but on pressure the tenderness is limited to one small point. Thus inflammation of a small bursa is the cause of a widespread "rheumatic" pain which only recently has been understood; and since many bursæ are not accessible to ready examination there is strong likelihood that similar pains in other parts of the body, as yet not definitely diagnosed, may be due to such inflammations.

The treatment of inflammation of a bursa consists of prevention of all pressure and motion. But as this generally involves more inconvenience than seems justified, it is usually not applied. Consequently, the bursitis continues somewhat obstinately. The bursitis of tennis elbow may be corrected by surgical removal of the bursa, which has been performed in a few instances with satisfactory results. The more serious inflammations in other bursæ, as in housemaid's knee or in a severely inflammed bunion, may likewise require surgical treatment. Inflammation of the subdeltoid bursa is sometimes followed by conversion of the bursa into scar tissue, causing permanent inability to raise the arm sufficiently to place the hand on the head. This condition may demand special treatment.

LUMBAGO AND STIFF NECK

Many pains in the back and neck which occur in connection with rotation of the spinal column are due to hypertrophic arthritis[3] of the spine. There are cases, however, in which the pain seems to be related to muscles or tendons, or conceivably to bursæ. Since these disorders are non-fatal and there has been practically no opportunity to examine the involved structures post-mortem, little is known concerning their causation. In many instances the onset is sudden, occurring in connection with some movement, suggesting that they are actual sprains. In others, exposure to cold seems to be a predisposing factor, and some inflammation of muscle or of fibrous tissue seems possible.

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[3] See section on Hypertrophic or Osteo-Arthritis in this chapter, p. 399.

The first measure in treatment is usually to limit the motion of the back by applying strips of adhesive plaster. External heat and massage are of value, and sometimes osteopathic manipulations are strikingly successful. In this connection, however, it is necessary to mention that violent manipulations may be harmful in cases with underlying organic changes, so that the practice of examination by a surgeon before such treatment is instituted is the rule of many osteopaths.

Allied to lumbago is a less frequent condition known as *pleurodynia,* causing pains in the chest suggestive of pleurisy.

POOR POSTURE AND FOOT STRAIN

Many children lapse into habits of relaxed posture, thus failing to maintain the proper muscular balance which keeps the body erect. The shoulders slump forward, the abdomen protrudes, the spine assumes unnatural curves, and in many instances the feet tend to turn outward and to relax, producing symptoms of strain or *flatfoot.* Such postural habits have been considered the result of general debility; but considerable evidence has been adduced to prove that, if permitted to remain, they are also the cause of debility. The application of corrective measures does much to improve not only the flaccidity or weakness of muscles but also the general health. For such children setting up exercises, gymnastics, and in extreme cases, special courses of training are of great value in promoting normal development and general welfare.

The results of improper posture and of muscular disuse in childhood are everywhere evident in adults of poor physique and unsatisfactory general health. While the consequences are chiefly limited to weakness and ready fatigue, this type of poor physical development predisposes to pulmonary tuberculosis, to chronic digestive disorders, and to nervous and mental disease. In adults, improvement of muscular tone and correction of postural defects are more difficult but they may be accomplished to an extent, and their effects on the general health are strikingly beneficial.

In most instances, *foot strain* or *flatfoot* is the direct result of muscular weakness and poor posture. The term flatfoot, however, lacks precision since there may be marked symptoms without actual flattening of the feet. Foot strain is a frequent abnormality, having been one of the chief causes of physical disability in those rejected for enlistment during the late war. In its minor grades, it is a handicap only when an individual is required to remain on his feet for long periods, but in the more severe forms it may be almost incapacitating.

The causes of foot strain are two: namely, (1) poor posture, which throws undue strain on the arches of the feet; and (2) underdevelopment of the muscles and ligaments which support the arches. Hard pavements, hardwood floors, and daily routine which involves much standing and walking are precipitating factors.

The symptoms directly referable to the feet are two: (1) those produced by strain of the longitudinal or anteroposterior arch of the foot; and (2) those due to strain of the transverse arch at the front of the foot near the base of the toes. At either of these places strain may amount to an actual sprain, instead of merely producing an ache after use. Strain of the transverse arch often causes extreme pain referable to the outer toes, because of pressure upon a nerve. Foot strain may also cause pains in the legs and knees.

By way of treatment, those cases of foot strain in which an element of sprain is present require the use of temporary mechanical supports, combined with diminished use or even rest in bed. Permanent relief of foot strain, however, is dependent upon proper muscular development of the feet, combined with improvement in posture. This fact should be understood by the layman. Various appliances for temporary relief are extensively advertised, but if such devices alone are employed, the foot will remain unequal to its purpose, requiring artificial aids permanently. If the acute pain indicative of an element of sprain is absent, or has been controlled by preliminary treatment, further improvement is possible by carefully graded exercises of the feet, and by the use of flexible shoes which promote muscular development.

DISEASES OF THE BONES

Osteomyelitis.—Osteomyelitis is a pus-forming inflammation of bone. It may be the result of local infection in a compound fracture, but the chief and more obscure form is due to infection carried to the bone from a distant part of the body. This occurs more frequently in children and is often a result of infection of the tonsil, of the ear, or of the skin. It is a disorder of sudden onset, with high fever accompanied by pain and tenderness over some bone. Prompt surgical treatment is essential, as operative procedure in the early stage of the disease does much to limit impairment. Otherwise, the condition may result in obstinately recurring inflammation for months or years, or in extensive damage to the bone often necessitating many operations.

Tuberculosis of Bones and Joints.—In children particularly the tubercle bacillus sometimes attacks bones, especially the portions of them adjacent to joints. The result is often serious damage not only to the bone itself but to the joint. The deformity of the humpback, familiar to every one, is the result of tuberculosis of the spine. Two other joints most frequently the seat of a tuberculous process are the hip and the knee, and the results of such disease are usually: (1) a permanent rigidity or loss of motion in the joint; and (2) shortening of the leg due to arrested growth. However, extreme deformities of the back, of the hip, or of the knee may usually be prevented by proper treatment before the disease has become too far advanced.

Unlike most other articular disorders, the onset of tuberculosis of the bones and joints is insidious and painless. Usually, the first symptom is a slight limp, or a tendency to rigidity in the joint affected. Upon medical examination, the involved joint is held rigidly by reason of contraction of the muscles controlling it and, in contrast to the rigidity manifested in most other articular affections, gentle attempts at manipulation do not produce pain. Later there may be swelling of the affected joint, but unaccompanied by acute inflammation. Usually slight fever is present each afternoon. In most instances the child is puny and below par in general health. A rather decided symptom is the "night cry," the child crying out during sleep as if in sudden pain. The symptoms in sprains may simulate those of tuberculous joints and for this reason the disease may be neglected in its early stages. Such neglect is disastrous, since the ultimate deformity of tuberculous bones and joints is usually inversely proportionate to the promptitude with which diagnosis is made and proper treatment instituted. Even under the best treatment, stiffness of the joint will usually be permanent; as a rule, however, the disease may be controlled so that the back is not visibly humped or the leg severely bent or contracted. The treatment consists of immobilization of the diseased joint by means of splints or plaster casts so applied as to maintain the most normal position, combined with the general measures employed in the treatment of tuberculosis.

CHAPTER XXXIV

GYNECOLOGY OR DISEASES OF THE FEMALE REPRODUCTIVE SYSTEM

While diseases of the female genital tract and disorders of its functions have a decided bearing upon the general health of women, it should be understood that its importance is frequently exaggerated by imaginative and superstitious persons. Nevertheless, it is a subject that deserves attention, and there is still much to learn about it.

Whenever anything seemingly abnormal occurs in the genital functions, or when there is an unsatisfactory state of general health in which a suspicion exists that genital disease may be present, a physician should be consulted. Most abnormal conditions may be definitely determined by proper examination. If no abnormality is found, it is important to cease thinking about it; if present, it requires adequate treatment.

For purposes of description these disorders and diseases may be grouped as follows: (1) functional disorders, such as abnormalities in menstruation; (2) anatomical abnormalities of the uterus, resulting both from abnormal development and from childbirth; (3) infections and their results, particularly gonorrhea; (4) miscellaneous abnormalities; (5) tumors and cysts.

DISORDERS OF MENSTRUATION

Normally menstruation begins between the ages of twelve and fifteen and continues until its natural cessation, usually between the ages of forty-five and fifty; when it begins relatively late the menopause usually occurs somewhat early. In growing girls, there may be irregularity or even omission of periods soon after onset, causing alarm to mothers, but ordinarily this is rectified spontaneously. Normal menstruation is regular, occurring about every four weeks and continuing for three or four days. Some discomfort or pain as well as certain less well-defined, general disturbances, such as nervousness, headache, or nausea, are so frequent immediately before and during the onset of menstrual flow that the slighter grades may scarcely be considered as abnormal.

Menstruation in the human female is a process the purpose of which is not wholly understood. It consists of a congestion of the lining membrane of the uterus and the discharge of a bloody secretion. It probably bears a relation to the passing of an ovum from the ovary, but the relative factor of time in these events is not definitely established. It is generally believed that impregnation is most likely to occur during the week following menstruation.

Amenorrhea or Non-appearance of Menstruation.—Aside from pregnancy there are conditions in which menstruation, though previously regular, may cease to occur. Such a condition naturally causes apprehension and should be discussed with a physician. It is true that cessation of menstruation is sometimes the result of serious disease; but in many instances it may be due to minor or undiscoverable causes and proves to be transitory and insignificant. Changes in the place or manner of living may be followed by temporary cessation of menstruation. If important causes can be excluded there is no occasion for alarm.

Dysmenorrhea or Painful Menstruation.—In many girls and women menstruation is preceded or accompanied by pain which is decidedly severe, and may be so intense and prolonged as practically to constitute continuous invalidism. The precise mechanism by which this pain is produced is uncertain, but in most instances some anatomical abnormality of the uterus is responsible.

Mothers should understand that abnormally painful menstruation in young girls should promptly be brought to the attention of a doctor, since if neglected it may become habitual and exaggerated by fear, while appropriate measures will frequently do much to alleviate it. Where medical management fails, and particularly in the presence of pronounced malpositions of the uterus, surgical procedure is advisable.

Excessive Menstruation, and Bleeding Independent of Menstruation.—Excessive menstruation may in itself be a cause of ill health, particularly of anæmia. Moreover, bleeding from the uterus apart from normal menstruation is always suggestive of a fibroid or some other growth. In older women it may even be due to cancer. It is therefore a symptom requiring medical advice.

MENOPAUSE OR "CHANGE OF LIFE"

Cessation of menstruation occurs between the ages of thirty-five and fifty-five, as extremes, and usually between forty and fifty. In the majority of all women there is some disturbance of the emotional equilibrium at this time, and often a curious tendency to flushing of the skin known as "hot flashes." The period is more or less disagreeable, but has no serious consequences save as a factor in producing nervous unrest. After the menopause, the temperament frequently becomes calmer, a highly satisfactory change. The uterus, the ovaries, and the external organs likewise diminish in size, and the mucous membrane becomes thinner and at times subject to irritation.

STERILITY

Women may fail to become pregnant, in spite of apparently normal conditions of married life. But, since the responsibility of the male in sterile marriages has been estimated to be as high as forty per cent, the potency of the husband should be definitely established, by microscopic examination of the semen, before investigating the causes of sterility in the wife. These may be various. In some women it may be due to an abnormality of the genital organs, which is sometimes found to be present even though the general physical development seems normal. In other instances there may be malposition of the womb; or there may be a chemical abnormality of the secretions. Gonorrhea affecting the fallopian tubes causes sterility. Medical examination usually reveals the presence of major abnormalities which interfere with pregnancy, and, in the absence of irremediable causes, treatment frequently makes pregnancy possible.

MALPOSITIONS OF THE UTERUS AND OTHER GENITAL ORGANS

In some women the uterus is misplaced or bent from faulty development. In other women similar abnormalities result from inflammation, from childbirth, or occasionally from injuries.

Abnormal positions of the womb from any cause may give rise to no symptoms, but in other instances they are apparently connected with painful menstruation, with pains in the back, and with various more remote complaints such as headache, indigestion, fatigue, and nervousness. On the other hand, much is attributed to "womb trouble" which as a matter of fact is the result of nervous exhaustion. Therefore, it is always wise to have the local condition determined by a medical examination, in order to avoid imagining that disease is present unless it is actually found to exist. In displacement of the womb which is a definite cause of symptoms, temporary improvement may result by wearing an adequate support, but surgical procedure is far more effectual and should usually be resorted to without undue delay.

Childbirth often results in tears of the outlet of the womb, known as the *cervix,* or of the *perineum,* the structure which forms the lower wall of the external genital passage, serving to some extent as a support of the uterus. Other structures supporting the uterus may also be stretched and weakened. Thus, after childbirth, a woman previously normal may develop local disorders. For these, reparative operations are ordinarily advisable. Gonorrhea [1] extending to the fallopian tubes and to the peritoneum about these structures may cause, among other disturbances, malpositions of the uterus.

OTHER DISEASES OF THE FEMALE GENITAL TRACT

The Ovaries.—There are many false notions and superstitions in connection with disease of the ovaries. Actually, however, the ovaries are anatomically well protected against injuries, and are little subject to disease, save that they are frequently the site of cysts and tumors. Most of the pains and discomforts referable to the ovaries are as a matter of fact not of ovarian origin. Inflammation of an ovary may be present in connection with gonorrheal salpingitis, with appendicitis, or following childbirth, and milder forms may occur in mumps or other diseases, but in such cases the ovarian involvement forms only part of a more widespread inflammatory condition.

The internal secretory function of the ovaries is still a matter of uncertainty. It is strongly suspected, however, that excessive menstruation is dependent upon increased ovarian function, while scanty menstruation and the flushing which accompanies the menopause are related to their functional deficiency. Preparations obtained from the ovaries of animals are administered for such disorders, sometimes with apparent benefit.

The Fallopian Tubes.—Gonorrheal infections of these organs has been discussed elsewhere.[1] Infections by other pus-forming organisms may occur after childbirth. Tuberculosis of the fallopian tubes, which occurs less frequently, is a disease of gradual onset and of chronic course. In any of these disorders of the tubes the treatment depends upon the individual features of the case. Surgery may or may not be indicated.

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[1] See section on Gonorrhea in the Female in chapter entitled Venereal Infections, p. 256.

The Uterus.—In childbirth, the uterus and its surrounding tissues may become infected, but apart from this the womb is little subject to inflammations. However, its lining mucous membrane is sometimes the seat of catarrhal processes, analogous to those of the nose and throat which produce abnormalities of secretion.

The External Genital Organs.—These may be the site of diseases of the skin as well as of primary syphilitic infection or of chancroid. The local changes following the menopause result in a certain tendency to local irritations in elderly women.

TUMORS

Both the ovaries and the uterus are peculiarly subject to tumors. These may be various, but all may be classified as either benign or malignant, the former being relatively harmless save for the effects of their size, while the latter, if untreated, invariably produce secondary growths (metastases) in other parts of the body and are eventually fatal.

Of uterine tumors the most frequent is the *fibroid,* a benign growth. Most small fibroids have no medical significance, but those resulting in pressure symptoms by reason of their size, and those which cause bleeding are best removed by surgical procedure. In recent years it has been found that the administration of certain X-ray treatments will usually cause fibroids to disappear without untoward results. Sometimes, however, the treatments may prove harmful, so that in many instances surgery is still preferable. After the menopause, fibroids tend to disappear spontaneously.

Cancer of any part of the uterus is a disease occurring chiefly during middle age or thereafter. Its development is usually insidious and painless, the growth sometimes appearing with but little warning, but if neglected it may quickly reach a stage in which it is irremovable by surgery. Therefore, women of thirty-five or over should understand that any bleeding other than that incidental to normal menstruation, as well as excessive discharge of the genital organs not necessarily accompanied by bleeding, are reasons for prompt medical advice. If operation is performed while the growth is small, there is a prospect of permanent cure; otherwise, the condition is usually fatal in one to three years.

Ovarian tumors, though very frequent, are not as apt to be malignant as are those of the uterus. Benign new growths of the ovaries usually contain sacs of fluid known as *cysts.* Some cysts of the ovary may contain one or more gallons of fluid thus growing to enormous size and producing marked enlargement of the abdomen. Occasionally, an ovarian cyst may be the seat of inflammation, giving rise to symptoms simulating those of appendicitis. As a rule, cysts and tumors of the ovary should be surgically removed, since neglect frequently involves considerable danger as well as discomfort.

CHAPTER XXXV

OBSTETRICS, OR THE CONDUCT OF CHILDBIRTH

The general physiology of conception has been elsewhere described.[1] It remains, however, to outline what is known in regard to the normal course of pregnancy and the process of birth as observed and assisted by the physician.

PREGNANCY

From its beginning pregnancy has certain general effects upon the body. Menstruation ceases, and tingling sensations in the breasts accompanied by a gradual increase in their size occurs. Increased pigmentation of the complexion is noted, particularly in brunettes. Nausea and perhaps vomiting is usually present, especially in the morning, beginning about the sixth week and continuing through the fourth month. Visible enlargement of the abdomen develops gradually. During the fifth month the mother becomes conscious of movements of the unborn child, and during the last three of the nine months of gestation the physician is able to hear the child's heartbeat by listening with a stethoscope.

Conclusive proof that pregnancy exists cannot be obtained in the early months, although at the end of the second month a skilled examination leaves no reasonable doubt. Small fibroid tumors, however, may cause enlargement of the uterus simulating pregnancy. When the child's movements and heartbeat can be detected by the doctor, the proof is absolute.

The average duration of pregnancy is two hundred and eighty days, and it is probable that conception usually occurs during the week following menstruation. The probable date of confinement is ordinarily estimated by counting back three calendar months from the date of the onset of the last menstruation, and adding seven days to that date.

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[1] See chapter entitled Reproduction, p. 107.

Disorders of Pregnancy.—In addition to the nausea already mentioned, other digestive disturbances may be present during the period of pregnancy, as well as a variety of discomforts such as itching, backache, and muscular cramps. There are sometimes more significant disorders during the course of pregnancy. These may be grouped in two classes: (1) that known as *toxemia of pregnancy,* having reference to the general health; and (2) disorders occurring in various forms, related to intra-uterine conditions.

Toxemia of Pregnancy. Occasionally, pregnancy may induce an abnormal condition of general health, the nature of which is not fully comprehended but which is similar in many respects to nephritis.[2] Two types of symptoms are recognized. The first of these is vomiting of such severity as to affect the patient's health, frequently accompanied by headache and abnormalities of the urine. The second is a condition far more grave known as *eclampsia*, which is marked by convulsions and unconsciousness. Although these conditions occur in only a small percentage of pregnancies, either of them is serious. By medical examination, however, it is possible to detect their warning signs before the symptoms have become pronounced. It is therefore important for all women to submit to periodical physical examination throughout the course of pregnancy, and promptly to report to their physician any new symptoms that may develop. Medical treatment does much to avert these dangers, but if the condition becomes threatening despite preventive measures active treatment is imperative.

Intra-Uterine Abnormalities. Abnormalities of the developing ovum and its attachments to the womb are various, but in most of them there is more or less uterine bleeding. The most frequent of these is known as *abortion,* which is death of the

[2] See section on Nephritis in chapter entitled Diseases of the Kidneys and Urinary System, p. 339.

ovum before the third month. This occurs from various known or unknown causes. It is preceded by bleeding or by pain, usually both. Absolute rest in bed and sedative drugs may still preserve the pregnancy, but if these fail, either the ovum is expelled, or it remains in the uterus as dead material about which inflammation may develop. Infections following induced abortions are frequent and death may result.

Contrary to popular supposition, miscarriage and abortion are not synonymous, *miscarriage* meaning, precisely, expulsion of the ovum from the fourth to the sixth month. It is less frequent than abortion but has the same medical significance.

Premature labor denotes labor before the normal nine months of pregnancy have been completed, but, in contradistinction to abortion or miscarriage, at a time when the child may possibly survive. After completion of twenty-eight weeks of pregnancy the child is so far developed that with careful management life outside the womb is possible. Protection against cold and handling together with careful feeding are essentials in the treatment of premature infants.

Extra-uterine or Tubal Pregnancy. A rare but serious condition results when the ovum, in descending from the ovary, becomes fertilized before it has passed through the fallopian tube and consequently attaches itself to the lining of the tube instead of to that of the womb. When this happens, the tube becomes so stretched, as the embryo grows larger, that at some time within the first three months of pregnancy it bursts, causing dangerous internal hemorrhage with pain and collapse. Extra-uterine pregnancy may be determined by careful examination, and demands immediate operation to prevent the grave results of spontaneous rupture.

Placenta Previa.—Sometimes the attachment of the ovum to the womb obstructs the uterine outlet. Bleeding toward the end of gestation is symptomatic of this condition which may become dangerous and requires skilled attention.

There are other abnormal developments which may occur within the pregnant uterus, but they are so rare as not to require separate mention.

Pregnancy in the Presence of Organic Disease.—Pulmonary tuberculosis is seriously affected by pregnancy. While the tuberculous condition is apparently not aggravated during pregnancy, it frequently advances rapidly after the birth of the child. For this reason pregnancy should be avoided by women who have or have had tuberculosis.

Heart disease increases the danger of childbirth, and women with heart disease should not become pregnant. On the other hand, skillful medical management during gestation, and particularly during labor, greatly reduce the dangers of childbirth in the presence of heart disease.

Pyelitis[3] is not an infrequent complication of pregnancy. Pressure of the enlarging uterus upon the ureters is thought to be the predisposing factor. The symptoms are of varying severity, and the condition may require long periods in bed, but it may be kept under control until the child is born, after which it usually disappears.

If acute diseases such as pneumonia develop during pregnancy, there is danger of abortion, miscarriage, or premature labor. Appendicitis during pregnancy may demand operation, since the risk of terminating the pregnancy must be taken to save life.

CHILDBIRTH

Normal Labor.—Expulsion of the fully developed infant from the uterus at the end of nine months of pregnancy is a physiological process known as labor or confinement. It involves a stretching or dilation of the mouth of the womb, and the passage of the infant outward through this outlet, through the ring formed by the bones of the pelvis, and through the vagina or external downward passage. The force necessary for this expulsion is produced by contractions of the muscular tissue of the womb.

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[3] See section on Pyelitis and Infections of the Kidney in chapter entitled Diseases of the Kidneys and Urinary System, p. 342.

It is generally estimated that in more than ninety per cent of all cases childbirth is possible without medical assistance. There is some reason to believe that among women of modern civilization the proportion may be smaller than among savages or peasants. It is nevertheless a fact that however great may be the advantages of medical assistance, nature alone is usually capable of accomplishing a satisfactory result.

On the other hand, there are instances in which abnormalities of the pelvic bones are such as to render childbirth impossible, or, in less pronounced deformities, may interfere with the natural delivery of the child. Moreover, by examination and measurements before labor, it may be determined with considerable accuracy whether the opening through which the child must pass is or is not adequate. It is one of the most important services of the modern obstetrician to detect in advance those cases in which labor cannot be expected to accomplish its normal result. In these, the operation known as *cæsarean section,*[4] or extracting the child through an incision of the abdomen of the mother, may be performed. Although such great deformities of the pelvic bones are comparatively rare, it is important to determine their presence before the time of confinement.

In the great majority of pregnancies the child is carried in the mother's womb head downward, and in the process of birth the head passes out before the shoulders and body. In a small proportion of cases, however, the position of the infant is such that the head is not nearest to the outlet of the womb. In such instances labor is more difficult, and delivery may be impossible without assistance. Examination shortly before or at the onset of confinement will show whether the position of the child is normal. If abnormal, special obstetrical management is required.

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[4] The development of this operation has resulted in its abuse. Some women, fearing the pain attendant upon normal childbirth, request delivery by this operation in preference to natural labor. It should be understood, however, that the mortality following cæsarean section is still considerably higher than that resulting from natural delivery.

The natural process of childbirth as previously described[5] is successful in the great majority of cases. Nevertheless, there is decided advantage in having the supervision of an obstetrician for the following reasons: (1) The natural process is a painful one, and medical measures are able to accomplish much to reduce the pain to a minimum and to shorten the period of labor; (2) the percentage of women unable to deliver themselves is not inconsiderable, and proper obstetrical assistance in these cases is imperative to save the life of the infant as well as that of the mother, since the infant may not be able to survive a prolonged labor even though the mother does; (3) medical care has as one of its prime objects the prevention of infection, which is the largest single cause of death in connection with childbirth. The danger of infection in women who give birth to children by purely natural methods is comparatively small, but that involved in assistance by ignorant midwives and by other untrained persons is considerable. The active measures of assistance which an obstetrician provides are always performed with extreme care to avoid the possibility of infection. Through medical attention directed toward these three objects childbirth has been converted from a process involving a definite percentage of mortality to one in which fatality is almost negligible.

Abnormal Labor.—In a proportion of confinements the natural process fails to proceed satisfactorily for definite, mechanical reasons, such as a deformity of the pelvic bones of the mother or an abnormal position of the infant. In more numerous cases, however, the reason is less tangible, seeming to lie only in deficient strength of the mother. In the most hopeless of these, active interference by the doctor is necessary or both the mother and the child will die. In those instances in which labor is somewhat delayed but where there is no mechanical impediment to its natural completion, most doctors feel that it is wisest not to interfere too precipitately. Nevertheless, as obstetrical skill and the precautions against infection have improved, it has become more and more possible to assist the process of delivery so as to minimize the suffering without incurring unwarranted risk. In cases in which the position of the child is normal, the method most frequently employed is the application of instruments called forceps to the infant's head. By making traction upon these the natural forces of expulsion are aided. The operation which is performed in those cases in which the infant's body lies across the outlet of the uterus, or is otherwise mechanically prevented from making the normal exit, is known as *version,* a procedure by which the child is turned within the womb so that the feet may be extracted first, the body and head following in the reverse of the normal order. Both of these procedures are performed under anæsthesia. The operation of cæsarean section has been mentioned, but when this is performed after prolonged ineffectual labor it is considerably more dangerous. The study of the many variations of the mechanics of labor is a highly developed branch of medical science which has led to well-established procedures depending upon the circumstances of the particular case, and the decision in each instance demands the wise judgment which only a well-trained, experienced obstetrician can give.

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[5] See section on Birth in chapter entitled Reproduction, p. 109.

Infections in Childbirth.—The uterus after childbirth may be compared with an internal wound, which, like other freshly incurred wounds, is liable to infection. Moreover, the condition of a woman at this time renders her less able to resist infection through the natural forces of immunity. For these reasons infections following childbirth are the cause of many deaths. As first demonstrated by Dr. Oliver Wendell Holmes, such infections must have their origin in something introduced from without. Before the principles of asepsis were known, they were frequently communicated by the hands of surgeons and of midwives. When precautions against infection were first used there was an immediate decided decrease in their development. Since then the methods have been further improved, with the result that infection has become even more rare; but it is nevertheless a danger which exists and cannot be too carefully avoided.

Recovery after normal labor may be compared with recovery from extreme and unusual physical exertion, coupled with recovery from a surgical operation. It requires a period of rest, uncomplicated by fever. Serious infections of the womb, however, produce fever some days after confinement. In the most severe instances the condition may be rapidly fatal.

Aside from the more serious infections, there are two conditions which are probably indirectly dependent upon milder infections of the womb. The first is a painful inflammation of the veins of the leg known as "milkleg." The second, which is rare but startling when it occurs, is the violent temporary insanity known as *puerperal mania.*

Breasts and Lactation.—The secretion of milk usually begins during the first twenty-four hours following childbirth. Previous to its regulation and before nursing becomes systematic and habitual, there may be some disturbance in the breasts due to overaccummulation of milk. In addition to this, infection may enter the milk-ducts through the nipples, resulting in inflammation and sometimes in abscess formation. Proper care of the breasts and nipples is important to avert these complications.

CHAPTER XXXVI

INFANCY AND ITS DISORDERS

NATURE provides that the infant be carried in the mother's womb until, at the end of the nine months, development has sufficiently progressed to render life possible in the outer world. At birth, as already described,[1] radical automatic changes occur in the physiology of the circulation, of the lungs, and of the digestive and urinary systems. Within a few moments after birth the infant cries vigorously, an act which involves breathing. The color of the skin and mucous membranes, which may be bluish at the moment of birth, becomes pink or red, indicating that the circulation of blood through the air-filled lungs is established. And, if any object of the size and shape of the mother's nipple comes in contact with the mouth, the newborn babe sucks vigorously, showing that the digestive tract is ready to function. Soon afterward urine is voided and feces are discharged. Thus the essential functions of independent life begin as soon as connection with the mother is severed.

PREMATURE INFANTS

Occasionally, infants are born before completion of the normal period of gestation. Because of this, they are not fully developed and may not be able to survive. If, however, the pregnancy has continued for seven months and there is careful management, the infant may not only live but may become in all respects as strong as full-term infants after the expiration of the time at which birth should have occurred.

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[1] See section on The Infant in chapter entitled Reproduction, p. 111.

The care of premature infants requires close attention to many details, including the following: (1) proper warmth, which may be insured by careful wrapping and maintenance of a room temperature ranging from 90° F. and 95° F., since the normal body heat of the infant is impossible in surroundings much cooler than the body temperature of the mother; (2) restricted handling, which should be reduced to a minimum; (3) extremely careful feeding, to supply sufficient nutrition in a manner involving the smallest mechanical digestive effort. At first it is usually necessary to give milk by a medicine dropper, and not to permit the use of the ordinary nursing bottle or to attempt nursing at the breast. Frequently, the outcome is largely dependent upon whether the feeble, premature infant has the physical strength to swallow enough of the proper nourishment to maintain life. The mother's milk, drawn artificially and somewhat diluted with water, is the best form of nourishment, but formulæ based upon cow's milk and milk sugar may be given.

BREAST FEEDING

Human milk differs distinctly from cow's milk, and while the latter may be modified so as to render its elements of nearly equal value with those of human milk, breast feeding is more advantageous especially during the first six weeks of the infant's life. Particular effort should therefore be made by the mother to nurse the infant at least for this period. Incidentally, it may be added that a larger proportion of mothers than is commonly believed are able to nurse their babies if they are willing to attempt it under proper direction.

Successful nursing is largely dependent upon systematic management. Perhaps the usual cause of failure lies in irregularity of the nursing hours, which is not only harmful to the mother but is also one of the chief causes of digestive disorders in infants.

Regular nursing by the infant is apparently the necessary stimulus to promote an adequate secretion of milk by the mother. Moreover, the infant cannot fully digest the nursing in less than two hours, and excessive nursing is a frequent cause of digestive disturbances. In hospitals where large numbers of cases are supervised it is the rule for vigorous infants to receive feedings at four-hour intervals (five in the twenty-four hours usually succeeding best); and for the less vigorous babies three-hourly feedings (six in the twenty-four hours, with an additional feeding at 2 A. M. during the first few weeks) have been found to be preferable to more frequent feedings. The quantity of milk the infant should receive in each twenty-four hours is another important consideration. Some infants do not thrive because of indigestion incidental to overfeeding; in others, insufficient feeding results in apparent pain and failure to gain weight. The only reliable way to avoid these two difficulties is to weigh the infant on accurate scales before and after each nursing. By computing the total gain for the twenty-four hours, the total consumption of milk may be exactly determined. If, from the beginning, the quantity of milk and the intervals between nursings are properly regulated, the infant should flourish and gain weight at the rate of about six or seven ounces per week. For normal infants, two and one-half ounces for each pound of body weight is usually considered the proper twenty-four-hour total of breast milk, subject to individual variations.

The most frequent difficulty in maintaining breast feeding is an insufficient supply of milk. As already stated, the stimulation furnished by regular nursing is the chief factor in promoting the secretion of milk. It is also important that the daily life and nutrition of the mother be wholesome. Abnormalities in the quality of the mother's milk may occur, but these are far less common than its deficiency. If the mother's supply of milk is sufficient, if too frequent and irregular nursing is avoided from the beginning, and if the proper quantity of milk is given to the infant at each nursing, breast feeding may continue normally for seven to ten months, when weaning is usually advisable.

BOTTLE FEEDING

Nature apparently intended that the infant should be breast fed during the first ten months of life, but it is probably true that in modern civilization this is less frequently possible than under more primitive conditions. In a large proportion of cases, the mother's milk supply becomes insufficient before the infant is able to take solid food, and therefore some liquid substitute for breast milk must be provided.

In bottle feeding, the best results are obtained by the use of cow's milk prepared in such a way that it will be as nearly like human milk as possible. Human milk differs from cow's milk in that it contains more milk-sugar and less protein and fat. Therefore, cow's milk should be diluted with nearly an equal amount of water, and must have milk-sugar or some other carbohydrate added to it. Despite this correction, however, preparations based upon cow's milk are less completely digested, and do not meet all nutritional needs so well as does human milk. In bottle feeding, the same rules apply concerning regularity and adequate but not excessive nourishment. The preparation of the formula and the amounts given should be determined by a doctor, since there are definite rules for estimating the requirements.

Usually preparations with cow's milk are boiled or pasteurized to kill any bacteria which may be present. And this is advisable unless the milk has been obtained from carefully conducted dairies. The process of boiling, however, destroys an essential vitamin in the milk, the lack of which may produce the disease known as scurvy.[2] Therefore, when infants are fed entirely from the bottle, orange or tomato juice should be given to supply this vitamin and so prevent scurvy.

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[2] See section on Diseases Due to Vitamin Deficiency in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 335.

DIGESTIVE DISORDERS OF INFANTS

Infants, and particularly bottle-fed infants, are subject to disorders of digestion, notably vomiting and diarrhea. In a large proportion of cases these disorders have their origin in some avoidable error of feeding. When once established the indigestion may continue obstinately. Irregularity, too frequent feeding, changes in the methods of feedings such as sudden weaning, and either overfeeding or underfeeding are some of the causes.

The preparation of the bottles and the method of giving them present many opportunities for mistakes. These may vary from too freely running rubber nipples to careless storage of the milk, resulting in souring, which may cause serious effects.

In deciding upon treatment, inquiry should be directed toward habits and methods of feeding to ascertain the cause of the difficulty in the particular case. The disorder usually subsides when all defects in the method of feeding are corrected. In aggravated instances, however, where the indigestion has continued until the child has become emaciated and weakened by malnutrition, the highest degree of medical skill and special facilities such as are available in hospitals are necessary to obtain improvement.

RARER ORGANIC DISEASES

A rare disease of the first few weeks of infancy is an obstruction of the outlet of the stomach which causes extreme vomiting and rapid loss of weight. It is known as *hypertrophic stenosis of the pylorus,* and is to be differentiated from the numerous other disorders with vomiting due to less important causes by visible movement of the stomach and by the presence of a small mass where the pylorus should be. A prompt surgical operation gives better prospect of recovery than any medical treatment.

Intussusception is a form of intestinal obstruction occurring almost exclusively in infants. There is a sudden onset of pain and vomiting, and soon blood appears in the stools. A mass in the abdomen is usually palpable by the physician. The only effectual treatment is immediate operation.

On rare occasions a newborn infant is found to have no opening or exit from the intestinal tract; this trouble is known as *imperforate anus.* Prompt surgical attention is obviously necessary.

INFECTIONS IN INFANTS

Disease displays itself differently in children and in adults. Tuberculosis, for instance, when it attacks the lungs in children, runs a rapid course and tends to extend to different organs and tissues of the body. In adults, it more commonly confines itself to the lungs and usually runs a slow course. Infants and young children are particularly susceptible to tuberculosis, which plays an important part in infant mortality. It is acquired either from close association with persons who have the disease or, in perhaps twenty-five per cent of the cases, from the milk of tuberculous cows. The pasteurization of milk is an important preventive measure, and the protection of children against association with tuberculous persons should be mandatory. Infantile tuberculosis is more easily prevented than successfully treated. After infancy, however, the incidence of tuberculosis is not so great, nor is it so rapidly fatal.

Syphilis is a disease of infancy, occurring sometimes in obvious form with rashes upon the skin by which it is recognized, or less evidently manifested by malnutrition. Laboratory examination of the blood of the mother is the method used to determine the presence of syphilis in the child. Treatment results in striking improvement.

Bronchitis and pneumonia are relatively frequent in infants and differ from these diseases in adults both in their symptoms and treatment. In particular, a moderately warm, moist atmosphere in the sick room is more suitable than the colder air indicated for adult cases.

Pyelitis may also occur in infancy. Usually, recovery takes place with little difficulty but occasionally the condition persists and requires special treatment.

RICKETS

Rickets is an important and prevalent disorder of children during the first three years of life. A considerable proportion of all infants have it in some degree and many adults show the effects of it throughout life, particularly in peculiarities of the bony development such as prominent square foreheads, knock-knees, and bow-legs. But in early childhood there are other effects of rickets which are of greater significance than this tendency to abnormalities of the bones. Infants with rickets, even in the first year, are pale, flabby, and weak. Sweating of the head is a symptom peculiar to the disease. Restlessness during sleep is usual, and in the more severe cases there may be convulsions. These infants are subject to colds and other infections, and are less likely to survive pneumonia or any other serious disease. Bony changes are present in the first year, but bowing of the legs becomes more marked as weight bearing begins. In severe instances the resulting deformity is extreme, requiring correction by surgery.

Insufficient sunlight is believed to be an important factor in the causation of rickets, the disease being prevalent in regions where there is little sunshine, and in infants kept indoors. The disorder is a manifestation of a disturbance in the utilization of calcium and phosphorus by the body.

In its prevention and treatment much is accomplished by systematic exposure to sunlight, or to artificial sunlight containing ultraviolet rays. General hygiene and proper diet are of importance. Cod-liver oil is of great value, serving the purpose of increasing the effects of sunlight.

CROUP OR SPASMODIC LARYNGITIS[3]

This disorder is extremely frequent in young children. It is an acute catarrhal inflammation of the larynx in which there occurs, during the night, a spasmodic closure of the larynx, which makes breathing difficult. Save that there has usually been a hoarse, croupy cough, the difficulty in breathing begins with little warning. For a short time it is both distressing and alarming, but it passes spontaneously. Drinking will generally stop it; vomiting always will. Immersion in a hot bath, inhalation of steam, and the administration of certain drugs may perhaps cause it to cease sooner, but usually it is over before the doctor arrives. When there are warnings that the child may have such an attack, the room in which he sleeps should be kept warm and moist; this is accomplished by croup-kettles or other appliances for producing steam. A balsam called benzoin is often added to the water.

Experienced parents usually learn that an attack of croup is of no serious moment. On the other hand, such difficulties in breathing must not be slighted by inexperienced persons, since *laryngeal diphtheria* and *acute septic laryngitis* which are distinctly dangerous[4] cause somewhat similar symptoms. In these latter conditions the child is usually quite sick before the difficulty in breathing appears; moreover, its occurrence is of gradual development in the course of hours instead of suddenly, and it fails to pass spontaneously. Besides, in diphtheria, the condition is better when the child is asleep; in spasmodic croup it is always worse. Therefore, while typical croup is not a serious matter and is many times more frequent than laryngeal diphtheria, it must be differentiated from the latter. If the difficulty in breathing has appeared gradually, or if there is not distinct improvement within fifteen or twenty minutes after the attack is recognized, it is wise to call a physician.

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[3] Two other types of abnormal breathing in infants, *congenital stridor* and *laryngismus stridulus,* are described in the section on Less Serious Disorders of the Larynx in chapter entitled Diseases of the Nose and Throat, p. 450.

[4] See section on Diphtheria in chapter entitled Infections, p. 224, and section on Acute Septic Pharyngitis in chapter entitled Diseases of the Nose and Throat, pp. 447, 448.

CHRONIC INTESTINAL INDIGESTION

A serious disease of moderately rare occurrence during the second year is a disorder of intestinal function producing very bulky grayish stools, and resulting in marked enlargement of the abdomen. There is malnutrition and retarded growth. The cause remains unknown and the treatment is not wholly satisfactory. The best results apparently follow a diet consisting of almost pure protein for a month or more after which other articles, notably ripe banana, may be cautiously added. The diet must be regulated carefully for a long period.

RECURRENT VOMITING OR ACIDOSIS

Many children are subject to attacks of vomiting lasting a day or two during which the breath has the characteristic sweetish odor of acetone, similar to that present in the acidosis of diabetes.[4] Remissions during which the child seems entirely well are the rule.

The cause of the disorder is unknown. The condition ordinarily occurs in nervous children, and frequently seems to be precipitated by unusual excitement, or sometimes by colds and other infections. By way of treatment, careful regulation of the daily life may do something to diminish the frequency of the attacks, and, if they present any recognizable warnings, rest in bed and a laxative are indicated. When the vomiting has begun nothing should be given by mouth, but if protracted and severe, the administration of fluids by rectum as well as other measures may be ordered by the physician.

The tendency to attacks is usually outgrown but sometimes migraine or sick headache results.

[4] See section on Diabetes in chapter entitled Diseases of Metabolism and of Disordered Internal Secretions, p. 330.

CHAPTER XXXVII

DISEASES OF THE SKIN

In a survey of the entire field of medicine, diseases of the skin embrace a more extensive and important specialty than is commonly supposed. In addition to the more usual disorders such as hives, eczema, and boils, there are a great variety of skin lesions, some of moderate frequency, others relatively rare, but all differentiated by dermatologists as entities. So complicated is the subject of skin diseases that it was one of the first branches of medicine to become a specialty, and today most physicians realize the advantage of referring all skin conditions of any moment to specialists for diagnosis and treatment.

Moreover, although the skin specialist knows far more about skin diseases than does the general practitioner, there is, nevertheless, much that remains unknown to him. For this reason the study of dermatology is at best highly unsatisfactory. Many of the most important problems are entirely unsolved. Even eczema, the most frequent of all skin diseases, remains largely a mystery; nothing is definitely known of the mechanism of its production, and consequently of its prevention. Something has been accomplished in its treatment, but not nearly so much as might be desired.

It is impossible here to name more than a small minority of the many diseases of the skin, but a considerable number cannot be disregarded. Erysipelas has been described among the diseases with general symptoms. Scarlet fever, measles, typhus fever, smallpox, chicken-pox, anthrax, pellagra, glanders, syphilis, and leprosy, are also diseases which show alterations in the skin, but since their constitutional effects are of greater significance than their skin manifestations they have been discussed as systemic diseases.

BACTERIAL INFECTIONS

Boils or Furuncles.—These pus-forming inflammations of the skin are due to bacterial infection usually by the *Staphylococcus aureus*. These bacteria gain entrance into a hair follicle from various external sources and cause inflammation which results in the familiar painful swelling and pus formation. The pus containing the bacteria, together with the dead tissue from the site of the inflammation is discharged after some days; then healing takes place. Lowered resistance to infection is undoubtedly a predisposing factor in the production of boils, and particularly in their successive occurrence. In their treatment, recovery may be hastened by slight incision of the skin to permit early drainage. Care should be exercised to prevent the pus from spreading as this may produce new boils. Vaccines are frequently used to develop bacterial immunity, particularly in persons who have low resistance, but the success in this method of treatment is extremely variable. Another therapeutic measure of some value is the ingestion of yeast.

Carbuncles.—Carbuncles resemble boils, save that they are deeper, more extensive, and tend to heal more slowly. In addition, they are accompanied by constitutional symptoms which may be serious. They are caused by a streptococcus. Surgical treatment is much more essential for carbuncles than for boils.

Impetigo Contagiosa.—This is an infection of the skin by staphylococci, and is often communicated from one child to another. It differs from boils in that the eruption consists of superficial pustules with relatively little inflammation beneath them. These, and the scabs which form after they break, may extend over the face and hands. Usually, a mild antiseptic ointment and cleanliness are sufficient to control the condition.

Tuberculosis of the Skin.—This form of tuberculosis, known as *lupus*, is an obstinate, disfiguring disease, usually confined to the face. As a rule it first appears in childhood, extending gradually from a small point of beginning over a wide area with an advancing margin leaving more or less scarring in the center. By various methods of exacting treatment the condition may be improved and occasionally overcome.

Syphilis.—As already described, syphilis may cause a variety of skin lesions. Aside from the general rash, usually occurring about two months subsequent to the primary infection, most of the skin changes appear after a year or more. One form simulates lupus; others bear resemblance to the lesions in *psoriasis*.[1] Many chronic ulcers of the lower extremities are syphilitic, and irregular "moth-eaten" thinning of the hair of the scalp is sometimes seen. These later syphilitic alterations in the skin may become disfiguring if neglected, but if promptly diagnosed and appropriately treated they are usually curable. Unlike the lesions of the skin and mucous membranes in the first year of syphilis, these later manifestations are apparently not transmissible.

SKIN DISEASES DUE TO PARASITIC FUNGI

In addition to bacterial infections of the skin, there are lesions which result from the growth of microscopic fungi on the surface of the skin. These are usually slightly more elevated than those due to bacteria. The disease misleadingly called *ringworm* is typical of these, producing circular areas of baldness on the scalp, or circular reddened and slightly scaling areas on the body. There is another parasitic disease, frequently transmitted from one person to another in gymnasia, which produces an itching eruption in the groins. Another widely prevalent variety may occur between the toes, usually between the fourth and fifth toes, occasionally spreading to the soles of the feet. All of these diseases are due to microscopic fungi growing on the surface of the skin. The actual organisms may readily be seen if the scales are placed under a microscope. All of these diseases are communicable. Except in ringworm of the scalp and in *favus*, another parasitic disease of the scalp, antiseptic ointments ordinarily control the infection. In ringworm of the scalp and in favus, carefully regulated X-ray treatments are usually applied, since simpler therapeutic measures are of little avail.

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[1] See section on Psoriasis in this chapter, p. 439.

DISORDERS CAUSED BY BODY PARASITES AND BITING INSECTS

Alterations in the skin caused by mosquito bites and flea bites scarcely require mention, but the continued presence of lice, and of the very minute animal parasite which causes scabies, may produce persistent skin diseases requiring continued treatment.

Scabies or "The Itch."—This is a rather frequent communicable disorder of children and of adults. It is extremely apt to be present in more than one member of a family. Its chief symptom is itching, which is felt particularly after going to bed and has the peculiarity of not involving the head. There is a rather inconspicuous eruption in the itching areas, and not infrequently pustular infection due to scratching. In children, the first marked skin changes are likely to occur particularly between the fingers and on the wrists, but usually the entire body, with the exception of the head and neck, is more or less involved. The disease is caused by a minute insectlike parasite which microscopically bears some resemblance to a louse. Proper treatment with substances that kill these mites and their eggs is promptly effectual. But unless this is applied to the entire body surface and unless the clothing worn prior to this treatment is thoroughly sterilized, the body will become reinfected. When several members of a family are infected, all should be treated simultaneously to avoid reinfection by each other.

Lice.—Lice are body parasites of the insect order, which in the process of evolution have so adapted themselves as to live on the body of a human host. A person previously free from lice becomes infested from close contact with another, as in army barracks or in refugee trains. The lice so acquired lay their eggs upon the body hairs or in the underclothing, and multiply enormously. The bites and movements of lice, combined with the uncleanliness of the skin and the scratching, produce irritation. Frequently, there is also a secondary infection of the scratched skin by pus-forming bacteria.

There are three varieties of lice: (1) body or clothing lice; (2) head lice; and (3) pubic lice. Under conditions of war, body lice are of great importance, as armies in the field invariably become infested. Moreover, typhus fever and the so-called *trench fever* or *Volhynian fever* are transmitted by the bites of these lice, which lay their eggs in the pubic hairs and in the clothing. Head lice are more or less prevalent among school children and among women with unkempt hair. They lay their eggs upon the hairs of the head, and these eggs are readily visible, appearing like dust grains, each one being glued firmly to the shaft of a hair. Pubic lice live and lay their eggs in the hair about the genitals, and cause itching in these regions. Body lice and head lice are almost identical, but pubic lice may be differentiated under the magnifying glass. Their eggs are reddish, not pearly white like those of body and of head lice.

Head lice and their eggs may be readily killed by continuous application of a towel which has been soaked for an hour in two and one-half per cent phenol in water. Caps worn before treatment is instituted should be sterilized by heat. All infected members of the same family, or playmates, should be treated simultaneously. In military delousing, or in the treatment of vagrants with body lice, the pubic hair is either shaved or treated with phenol solution and the body bathed. The clothing must be sterilized. Pubic lice may be treated similarly or with various ointments.

SKIN DISEASES DUE TO EXTERNAL CONDITIONS

Many disorders of the skin are due to external irritants. Of these, sunburn is the simplest example, being caused by the irritant action of ultraviolet rays of the sun. It may be prevented by application of an ointment covered with a powder before exposure. Other illustrations are inflammations of the hands and arms resulting from the use of strong soaps and washing powders, and from a wide variety of chemicals used in modern industries. Leather workers who come in contact with chromic acid develop small, deep ulcers of the skin which are very slow to heal. These are but a few illustrations of skin diseases due to external irritants.

Ivy Poisoning.—The ordinary poison ivy contains an oil which is an intense irritant to most skins, although individuals vary in their susceptibility. The common primrose and the Chinese lacquer of Mah Jong sets have a similar effect upon certain people. Soon after contact with any of these, a susceptible skin develops redness, itching, and an eruption consisting of minute blisters. The itching and inflammation continue for days or weeks. Immediate and thorough washing with soap and hot water to remove the oily, irritating substances is generally effective. Various lotions may be used to diminish the itching. There is a newly developed antidote for ivy poisoning which is administered by hypodermic injection. In cases severe enough to justify the discomfort involved, this method of treatment should be considered.

Urticaria or Hives.—This frequent disorder seems to be a skin reaction to some ingested substance to which the individual is abnormally susceptible in a peculiar way. But the connection between the skin reaction and the particular cause cannot always be established in individual cases. The urticarial reactions which follow the injections of antitoxins and those which some persons have after eating shellfish, strawberries, or other foods to which they are idiosyncratic, are clearly due to these factors. However, there are other attacks of hives that occur without clear cause. Because of their similarity, it is generally concluded that they are results of the same process, perhaps due to abnormal fermentations in the intestinal tract; but this remains unproved. Urticaria, asthma and hay fever all present similar problems.

If the cause is known the treatment of urticaria consists merely of its elimination, combined with measures to diminish the itching. Where the cause is unknown, the intestinal tract is thoroughly emptied, and the diet restricted to a few simple foods. For severe itching due to urticaria, a hypodermic injection of the active principle of the adrenal gland gives prompt relief.

SKIN DISEASES DUE TO INTERNAL CAUSES

Eczema.—Eczema is the most frequent of the more troublesome skin diseases but it is still an unsolved problem. Since the disease is not yet precisely differentiated, there is no unanimity of opinion as to whether certain eruptions should be classified as eczema. Thus, some authorities include under eczema some skin diseases caused by external irritants. These, however, are better classified as dermatitis, reserving the term eczema for those not due to external causes. In some cases of eczema, foods or drugs taken internally may be a factor. In infantile eczema the rash sometimes appears after cow's milk has been substituted for human milk; and in certain instances of the disease in adults, diet and intestinal conditions bear some relation to its incidence. But such factors are not as clearly determinable in eczema as in urticaria.

Eczema may occur in different forms varying from the most acute with redness and blistering to chronic varieties with only scaling and thickening of the skin. Itching is a troublesome symptom in all forms, and scratching aggravates the condition. Owing to the obscurity of its causation and its nature, the treatment of eczema is confined to the application of soothing lotions and ointments to diminish the itching and to supply protection, together with elimination of irritants, particularly soap and water. In eczema it is usually better to cleanse the affected area with olive oil. The diet and mode of living should be regulated to meet the requirements of each case.

Herpes Zoster or Shingles.—This rather frequent disorder, manifested by an eruption of vesicular patches resembling cold sores, is described under diseases of the nervous system since the cause is known to be in the nerves, although the visible change is in the skin.

Acne.—A large proportion of all adolescents of both sexes are affected to some degree by blackheads (*comedones*) and pimples of the face. These are of no consequence to the general health but are distressing on account of appearances. The condition is known as acne. While its nature is not definitely established, the fundamental factor in its causation seems to be some change in the skin which occurs in connection with puberty. The condition is not primarily a bacterial infection. Its first visible abnormality is the accumulation of dry greasy material in the gland ducts, forming blackheads, each one of which produces a susceptibility to secondary pus-forming bacterial infection about it. The bacteria found in the pus of acne pimples are various, but no one of them can be definitely considered as its primary cause.

Acne is usually difficult to control, continuing to manifest itself more or less until the third decade of life. Usually, however, something may be done to diminish it. The treatment is both systemic and local. The first includes regulation of the bowels; simple diet with elimination of special foods which are found to be unfavorable in the individual case; and, in girls, attention to disorders of menstruation. Local treatment consists of removal of all blackheads with some instrument. Otherwise the treatment of the skin depends chiefly on measures classified as stimulation, that is, those which tend to increase the circulation while avoiding irritation. Thorough washing with soap and hot water each night is the simplest method. Many lotions and ointments are of considerable use. Ultraviolet light exposures are of value and X-ray treatments sometimes result in improvement, but to be safe these should be administered only by experienced physicians since overexposure may result in more serious disfigurement.

At present there is extensive advertising by many irresponsible "companies" urging X-ray treatment to remove superfluous hair, acne, and other blemishes of the skin. For the protection of the public, one fact should be emphasized and understood in connection with skin diseases. *X-ray exposures are by no means harmless.* They produce no sensation at the time of administration, and no immediate change in the skin is apparent; but intense and protracted exposures, such as those necessary to remove hair, may result in disfiguring alterations in the skin in subsequent months or years. Meanwhile the advertising "company" has usually disappeared, so that even financial redress is impossible. X-ray treatments of the skin should never be permitted except by physicians of known reliability.

Seborrhea.—Certain common abnormalities of the skin, and particularly of the scalp, are due to extreme variations in the amount of natural oily secretion. The skin may be abnormally oily, or abnormally dry. While this oiliness or dryness is usually most pronounced on the scalp, it may be noticeable on the facial skin, and on that of the body. Sometimes there is an associated state of irritation known as *seborrheic dermatitis* or *seborrheic eczema.* Seborrhea of the scalp is a factor in certain cases of premature baldness. There are various theories concerning its cause. Infection communicated through barber shops is considered a suspicious factor. Other facts are more suggestive of some unknown constitutional cause. The local treatment consists chiefly of shampooing and bathing, and the application of mildly stimulating ointments.

Psoriasis.—This disease is of rather frequent occurrence and is marked by the appearance of round, scaling, indurated patches, usually most abundant on the outer aspects of the arms or legs, and on other bony prominences including the scalp. Each patch is of the size and shape of a coin, and has an accumulation of whitish scales on its surface. If these are removed, a circular, reddened base is visible. Except in the more severe cases, which sometimes present joint disorders as well, there is no apparent unfavorable effect upon the general health. The skin eruption, however, is difficult to control and when finally removed tends to reappear indefinitely. The cause is unknown. In many cases there seems to be a relationship between the appearance of the skin lesions and internal disorders, since eruptions sometimes occur after diseases such as tonsillitis, and some persistent cases temporarily recover after the removal of a chronic local infection. Regulation of weight also tends to exert a temporary beneficial effect on the disease. Arsenic internally is sometimes of value. For local treatment there are numerous ointments which are useful in removing the scaling patches, if applied persistently. Careful administrations of ultraviolet and X-ray treatments have some value.

TUMORS OF THE SKIN AND ALLIED ABNORMALITIES

Keratosis Senilis.—This is a term applied to the scaling spots frequently seen on the face and hands of many elderly persons, particularly of those much exposed to the weather. These are of some significance since a small proportion of them may eventuate in epithelioma. They are easily and thoroughly removable by radium and should be so treated.

Epithelioma.—Elderly persons and particularly those who have keratosis, are subject to slow-growing, small tumors of the face, which usually eventuate in open ulcers. Actually, this condition is cancer of the skin, but it is a variety of cancer which in most instances is relatively benign. Treatment is imperative, otherwise the disease will progress. With proper treatment, however, the slowly growing type is usually curable.

Cauterization, surgery, radium, X-ray, and other newly developed methods may be used, depending upon the size and location of the tumor and upon the therapeutic facilities at hand. As one variety of epithelioma is dangerous to life, a physician should be immediately consulted in every instance to determine the nature of the growth.

Pigmented Mole and Melanoma.—Moles of the skin which are blue-black rather than brownish are potentially dangerous, since they are allied to sarcoma, and some of them after being harmless for years become active or undergo changes which may be followed by the development of sarcoma elsewhere in the body. For this reason such moles should invariably be removed, no matter how benign they seem. Brownish or colorless moles, whether smooth, warty, or hairy are of no consequence save as blemishes. They are removable by various methods.

Birthmarks.—Several varieties of such marks exist. For the most part they are abnormal dilatations of blood-vessels, and may disappear in the course of childhood. In some, cauterizations, X-ray treatments and other methods are of value, either in eradicating the mark or in rendering it less conspicuous.

OTHER DISEASES OF THE SKIN

It would be possible to multiply this cursory outline of skin diseases many times by mentioning other well-known disorders. Some serious and even fatal diseases have been omitted because they are comparatively rare. Other abnormal conditions of the skin, such as premature baldness, freckles, warts, and corns have not been included because of the necessarily limited scope of this volume.

CHAPTER XXXVIII

DISEASES OF THE NOSE AND THROAT

The nose and throat, which form the complicated route through which air passes before entering the windpipe, are subject to numerous abnormalities. Some of these cause only minor discomfort or inconvenience; others have far-reaching effects upon the general health. Only the more important conditions will be discussed here.

The nose serves as a roof over the two nostrils, and these are separated, within the nose, by a vertical plate of bone and cartilage, which extends backward into the head separating the internal air passage into two divisions. Although the nostrils are quite small, the air cavities behind them occupy nearly all of the space in the head above the roof of the mouth and below the eyes. In addition, there are two extensions in open communication with the air in the nose; these are located one above each eye and are known as the *frontal sinuses*. There are many other such chambers or sinuses which the air from the nostrils is free to enter. The interior of the nose and all of its connecting sinuses are lined with mucous membrane.

AFFECTIONS OF THE NOSE

Coryza.—The mucous membrane of the nasal cavity may be affected by a catarrhal inflammation known as *coryza*, the symptoms of which are familiar to all. Various other causes, notably hay fever, may produce swelling of this membrane accompanied by a watery discharge. The membrane may also be abnormally dry, in which event there is often an offensive odor.

Nosebleed.—In nosebleed the bleeding point with few exceptions is just within the nostril, close to the front on its inner side. Anyone may have bleeding from the nose as the result of a blow or other violence, but those subject to repeated nosebleeds usually have an abnormal development of the small veins in this region which may be corrected by cauterization.

Broken Nose, Deviations of the Septum.—The bones of the nose may be fractured by a blow, a fall, or other violence and, unless the displacement is readjusted at once, permanent deformity may result. In many persons the central bone of the nose is not quite straight and may even be so bent as to interfere with the passage of air on one side. Unless there is obstruction to breathing, deformity of the bones of the nose, whether the result of injury or of natural growth, is unimportant save for appearances. But if there is obstruction to nasal breathing, cough and throat affections frequently result. Usually, obstruction in the anterior part of the nasal cavity may be corrected by slight operations.

Serious Diseases.—Syphilis, tuberculosis, and cancer are among the more serious diseases of the nose, the throat, and the pharynx.

SINUSITIS

The sinuses or air cells, enclosed in the bones of the face and communicating with the nasal passages by relatively small openings, are subject to acute and chronic inflammations. A simple cold in the head may result in *acute sinusitis,* which in turn may become chronic, but the latter is usually dependent upon structural defects, such as an abnormally narrow opening that does not readily permit the natural escape of pus or other material from the sinus.

Sinus disease is spoken of under the name of the particular sinus involved. Thus, *antrum disease* is that involving either or both of the large sinuses (*antra*) which lie in the cheek between the floor of the eye socket and the upper teeth. *Frontal sinusitis* is disease of either or both of the frontal sinuses which lie above the eyes. *Ethmoid* and *sphenoid sinusitis* involve sinuses far back in the roof of the nasal cavity.

Acute Sinusitis.—The chief symptoms of acute sinusitis are pain and headache centering in the region of the affected sinus. The pain usually lasts about a week, and has the peculiarity of being most severe about noon, subsiding each night only to recur on the following day. Treatment of acute sinusitis consists of applications to the interior of the nose to diminish the swelling of the mucous membrane, and drugs to alleviate the pain.

Chronic Sinusitis.—This disease frequently remains unrecognized for long periods. Sometimes no local symptoms are evident, the condition being found only when search is made for a focus of infection to determine the cause of other existing diseases, such as arthritis or asthma. Although in some cases there may be repeated symptoms like those of acute sinusitis, or headaches and neuralgias, the local symptoms in other instances may be so vague as not to point to disease of the sinus. X-ray examinations are important aids in diagnosis. Chronic sinusitis usually requires some operation to enlarge the opening between the sinus and the nasal cavity.

HAY FEVER

Hay fever, asthma, and *urticaria* (hives) are all manifestations of the abnormal reaction of certain individuals to specific foreign substances. In an individual who is peculiarly sensitive to a certain substance, its entrance into the body is rapidly followed by the symptoms of hay fever, or asthma, or hives. Hay fever is that familiar seasonal disorder involving obstruction and running of the nose and eyes; the most frequent cause is sensitiveness to pollen of the ragweed. Other agents, however, may likewise be responsible. The season of the symptoms indicates to what group the offending substance belongs, tree pollens prevailing in spring, grass pollens in early summer, and weed pollens in late summer. Orris root toilet powder is an occasional cause. Skin tests are employed to detect the individual sensitivity to particular substances. Two forms of treatment are available: (1) removal to a region of different vegetation so as to avoid contact with the causative agent or agents; or (2) the development of an immunity by means of injections of graduated doses of the offending substances. The latter method is sometimes strikingly successful.

DISEASES OF THE NASOPHARYNX

The *nasopharynx* is that part of the nasal cavity which lies farthest back, and extends above the portion of the throat which is visible when the mouth is open. The posterior wall of the nasopharynx is continuous with the back of the throat. The nasopharnyx is particularly subject to chronic irritations. Though uncomfortable, these are not serious, save in their relationship to diseases of the ear.[1] Some of these irritations are the result of sinus disease.

Adenoids.—Adenoids are an excessive development of the normal lining of the nasopharyngeal wall. A large proportion of all children have some excess of lymphatic tissue in this region, and in some the overgrowth is so marked as to obstruct the passage of air from the nose to the throat. Children with large adenoids are subject to colds, to general ill health, and particularly to disorders of the ear. Because of continued mouth breathing, their faces change in form and their teeth implant irregularly. If adenoids are not removed the child may suffer impairment of mental development. Adenoids are removable by simple operation.

DISEASES OF THE TONSILS

The tonsils are two small glands lying on either side of the throat at the level of the base of the tongue. When enlarged, they form strawberry-like masses of tissue. *Acute tonsil-*

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[1] See section on Chronic Disorders of the Pharynx in chapter entitled Diseases of the Ear, p. 453.

litis is described elsewhere.[2] *Chronic tonsillitis,* or enlargement of the tonsils, is present in a large proportion of all children and is usually accompanied by adenoids. As a rule the enlargement shrinks or disappears after childhood but it may persist. Simple enlargement of the tonsils is not necessarily harmful, but many persons with enlarged tonsils have repeated attacks of acute tonsillitis. There is also evidence that diseased tonsils are the exciting agent of certain diseases of infectious origin, notably rheumatic fever and endocarditis. For these reasons it is frequently advisable that tonsils be thoroughly removed. In children, the discomfort incidental to this operation and its recovery is of no consequence, but in adults it is more marked. All cases of suspected tonsillitis should be seen by a physician to rule out the possibility of diphtheria.

OTHER ACUTE INFECTIONS OF THE THROAT

Diphtheria.—Diphtheria resembles tonsillitis in its acute manifestations of sore throat and fever, but the condition is so much more grave that it is classified as a systemic disease, and is therefore described elsewhere.[3]

Vincent's Angina.—This disease occurs more frequently than is generally supposed. It is an ulceration within the mouth caused by the combined action of the two organisms of Vincent, a spirillum and a spindle-shaped bacillus. Such ulcers are usually on the tonsil, and are accompanied by some fever; the condition therefore may simulate either tonsillitis or diphtheria, but it is definitely determinable by bacteriological examination. The same organisms attacking the gums produce *ulcerative stomatitis* or "trench mouth," and in rare instances they may even cause disease of the lung. Ordinarily, infections of this variety are not serious, recovering in one to two weeks without treatment other than cleansing washes. The arsenious preparations particularly arsphenamine are of

[2] See section on Tonsillitis in chapter entitled Infections, p. 240.

[3] See section on Diphtheria in chapter entitled Infections, p. 223.

some efficacy, and may be used when necessary to control them.

Acute Septic Pharyngitis.—Acute septic pharyngitis or "septic sore throat" is a condition closely allied to tonsillitis but more severe in its symptoms. It may occur in severe local epidemics which sometimes have been due to infected milk, or to ice cream made from such milk. The inflammation may extend to the pharynx and also to the larynx. In general, the treatment is similar to that of tonsillitis, but careful medical supervision is still more necessary as there is a greater tendency to complications in other parts of the body.

Acute Pharyngitis.—When there is complaint of "sore throat" and the illness is only slight, the condition is usually due to a mild inflammation of the back of the throat not involving the tonsils, known as *acute catarrhal pharyngitis.* In this disorder the throat appears somewhat reddened and there is a scratchy sensation on swallowing rather than actual pain, usually accompanied or followed by symptoms of coryza. Painting the throat with various astringents and gargling with hot salt solution may be advantageous, but in any event spontaneous recovery soon occurs.

Chronic Disorders of the Pharynx.—The pharynx is that structure of the throat, behind the tongue and soft palate, through which food and air pass. The posterior wall of the pharynx, which is the farthest part visible as one looks into the open mouth, is subject to chronic abnormal conditions associated with varying degrees of tickling or burning sensations. These are of three varieties: (1) simple redness; (2) irregular nodular appearance; or (3) abnormal dryness with an accumulation of dried secretions. Tobacco smoke, inhalation of dusts and irritant vapors, or an excess of highly seasoned foods may be contributing causes. Nasal obstruction with resultant habitual mouth breathing, or disease of the nasal sinuses may be the underlying causes. Straining of the voice is a factor in the second variety, sometimes called "clergyman's sore throat."

Treatment includes local applications as well as the employment of such corrective measures as are basically indicated.

DISEASES OF THE LARYNX

The larynx or Adam's apple, or that structure between the windpipe and the throat which is the seat of the voice, is subject to inflammations similar to those of the nose or of the pharynx, but with the variation in symptoms peculiar to disturbance of its particular function.

Acute Catarrhal Laryngitis.—This is a disturbance analogous to cold in the head, and its chief symptom is temporary hoarseness or loss of voice. With the aid of a small, obliquely bent mirror which reflects the structures behind the tongue, the throat specialist may view the mucous membrane of the interior of the larynx. This is found to be red and swollen. The condition usually subsides spontaneously in a few days, but it may persist by reason of injudicious use of the voice, unnecessary coughing, and breathing cold, dust-laden or otherwise irritant air through the mouth. Soothing inhalations of steam or fine sprays are of some value.

Spasmodic Laryngitis.—Croup, which is another name for this disease, has been elsewhere described.[4]

Obstructions of the Larynx.—All air which enters the lungs must pass through the larynx. This organ has a distinctly narrow opening at the point where the vocal cords lie, which may become completely obstructed. Sometimes a bit of food "going down the wrong way" closes the opening, and unless dislodged will cause suffocation. Diphtheria of the larynx, acute septic laryngitis, which is usually a phase of the same disorder that produces acute septic pharyngitis[5] and other conditions that cause swelling in the region of the vocal cords, may narrow the air passage so as to threaten suffocation. Obstruction of the larynx constitutes an emergency which may demand surgical interference. When it becomes obvious that the entrance of air is so labored as to result in suffocation or fatal exhaustion if the obstruction continues, the windpipe (*trachea*) is cut by making an opening in the throat below the point of obstruction to permit the ready passage of air through this new opening to the lungs. This operation, known as *tracheotomy,* has saved many lives. When there is no longer any danger of obstruction the wound in the neck is allowed to heal.

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[4] See section on Croup or Spasmodic Laryngitis in chapter entitled Infancy and Its Disorders, p. 429.

[5] See section on Acute Septic Pharyngitis in this chapter, p. 447.

Syphilis not infrequently attacks the larynx and sometimes the scars which follow the healing of the lesion cause permanent narrowing of the air passage.

Tuberculosis of the Larynx.—Tuberculosis of the larynx is a frequent accompaniment of pulmonary tuberculosis. Sometimes the laryngeal symptoms appear before disease in the lungs is recognized, and examination of the larynx gives the first evidence of the presence of a tuberculous process. In such cases, prompt institution of the general treatment of tuberculosis may be followed by recovery. In other instances the larynx becomes involved as a complication of previously recognized disease of the lungs; this adds to the discomfort and is ordinarily an unfavorable sign. The cough is aggravated; the voice is weakened or lost; swallowing becomes painful and in the advanced stages it becomes difficult to avoid "swallowing the wrong way." Applications to the larynx are of some benefit, with the addition of the general treatment indicated for tuberculosis.

Cancer of the Larynx.—The gradual development of hoarseness in older men is always suggestive of cancer of the larynx. It is a symptom which should not be neglected, as cancer of the larynx is not infrequent, and as it is a form of cancer in which early operation will often effect a cure. If hoarseness after middle life continues for more than a week or two, a physician should be consulted.

Less Serious Disorders of the Larynx.—Occasionally, peculiar sounds accompany breathing in infants. These are of two varieties: (1) a croaking or clucking sound with each breath known as *congenital stridor;* and (2) a momentary difficulty in breathing occurring in irregularly recurrent attacks, known as *laryngismus stridulus.* The first is of little significance, usually disappearing during the second year. The second seems to be a manifestation of rickets and its attacks cease after the age of two years. In the more severe cases application of X-ray treatments to the thymus gland have been recommended.

In locomotor ataxia, spasms of the larynx may be occasional complications. Paralyses of the muscles of the larynx, causing changes in the voice, occur in various conditions affecting the nerves which supply these muscles.

Loss of voice or *functional aphonia* is a rather rare disorder without manifest disease, usually due to some emotional disturbance. It is a form of hysteria.[6]

Small growths which appear on the edges of the vocal cords, particularly in singers, causing weakening of the voice are known as *singers' nodes.* With rest of the voice they tend to disappear. Small benign tumors sometimes develop upon the vocal cords and interfere with voice production. The throat specialist is usually able to remove them if it becomes necessary.

Foreign Bodies in the Air Passages and Esophagus.—Beans, small buttons, and other objects pass through the windpipe and lodge in the chest, producing serious results. In recent years throat specialists have greatly improved the technic of locating and removing such foreign bodies through long tubes inserted into the trachea. Objects which have lodged in the esophagus between the mouth and the stomach may be similarly extracted.

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[6] See section on Hysteria in chapter entitled Diseases of the Nervous System, p. 375.

CHAPTER XXXIX

DISEASES OF THE EAR

THE ear is naturally thought of as the conspicuous external appendage on the side of the head, but the more important acoustic structures lie deep within the temporal bones of the skull. The outer ear, or *auricle*, serves only to receive sounds. The sound waves of the air perceived by the sense of hearing are those which enter the deep hole in the middle of the ear and produce vibrations of a structure, known as the *drumhead,* which closes the inner end of this canal. The *ear-drum,* like the head of any drum, is a thin parchment-like membrane with air on either side of it; its outer surface is exposed to the air of the external passage of the ear; its inner surface forms part of the outer wall of an air chamber lying within the temporal bone and connected by an air-transmitting tube with the back of the nasal cavity.

This chamber, which receives its air from the nose and is separated by the drum from the external air passage of the ear, is known as the *middle ear.* Extending backward from the main chamber of the middle ear there are a series of communicating air cells called the *mastoid cells.* Inflammations of the middle ear, and of the mastoid cells which extend behind it, are the most frequent of the more serious diseases of the ear.

The inner surface of the ear-drum is connected with the inner wall of the middle ear by three minute bones with joints between them. The chain or bridge composed of these little bones serves to transmit the vibrations of the drum across the cavity of the middle ear to a structure known as the *cochlea,* which lies still deeper in the head surrounded by bone, and is the end organ of the auditory nerve, which comes up to it through the bone from the brain.

Just behind the cochlea and also inclosed in bone is another structure composed of the three semicircular canals. These are little, curved, fluid-containing tubes, that serve somewhat the same purpose as three spirit-levels, such as are used by carpenters, each one being directed in one of the three diameters of the skull. The semicircular canals have nothing to do with the acoustic sense, but are the organs of equilibration as will be explained later. A branch of the auditory nerve extends to these through the bone. The cochlea and the semicircular canals together compose the organs of the *internal ear.*

In hearing, the sound waves of the air cause vibrations of the drum and these are conducted across the middle ear by the chain of bones to a second drumlike membrane, beyond which they are transmitted in the cochlea to the auditory nerve. Probably some sound waves are passed directly through the air of the middle ear as well as through the chain of bones. It is also true that strong vibrations are transmissible through the bones of the skull directly to the cochlea and auditory nerve, so that under certain circumstances sound may be heard as the result of vibrations other than those which pass through the ear-drum and middle ear. This fact is of importance in determining the particular cause of deafness.

The auricle or external ear is affected only by injuries, by frostbite, and by skin diseases.

The external auditory canal or entrance to the ear often becomes obstructed by accumulations of its secretion, known as *wax* or *cerumen.* This results in a form of deafness easily diagnosed and remedied. Foreign bodies, such as seeds or beans, sometimes become lodged in the air passage, requiring removal by a physician. Boils of the skin of the air passage are frequent and painful, but they do not lead to inflammations of the middle ear.

Rupture of the drum membrane is not infrequent. Its occurrence is accidental, usually as a result of some injury involving penetration into the air passage, or of loud explosions close to the ear. As a rule, healing is spontaneous. Syringing an ear injured in this way is unwise, but the canal should be protected with cotton. The otologist knows of measures to hasten healing and to effect recovery.

Adenoids[1] bear a significant relationship to diseases of the middle ear. Inflammations of the nose occurring in colds often extend to the middle ear, since this structure is, in effect, a posterior chamber or extension of the nasal cavity. Abnormal conditions at the back of the nasal cavity may likewise affect the *eustachian tubes*, through which the air passes from the nasal cavity in and out of each middle ear. Normally, these tubes open with each act of swallowing, but when their function is impaired there is imperfect adjustment of the air pressure within the middle ear and against the internal surface of the drum. As a matter of fact, many diseases of the ear originate from nasal abnormalities.

AFFECTIONS OF THE MIDDLE EAR

Earache.—Following coryza or tonsillitis (which is always accompanied by inflammation of the adenoids), and also in measles and scarlet fever, earache (acute inflammation of the middle ear) frequently occurs as a complication, especially in children. There is rapid development of pain deep within the ear which is usually severe. This is caused by inflammation of the mucous membrane within the middle ear resulting in an accumulation of fluid which cannot make its escape because the eustachian tube is closed. This produces pressure against the ear-drum, which, on examination, is seen to be reddened and to bulge outward. If the condition persists and no treatment is instituted the drum is likely to burst which allows the fluid to escape through the external canal; this constitutes a "running ear." Such a discharging ear may recover spontaneously, but there is danger that it will not heal properly and extremely serious complications may occur.

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[1] See section on Adenoids in chapter entitled Diseases of the Nose and Throat, p. 445.

In all cases of earache it is therefore urgent to call a doctor promptly, since in all of the more serious instances the ear-drum should be punctured. If this is done, the pain is not only relieved, but there is also far greater likelihood that the inflammation and discharge will subside promptly, and that impaired hearing and other dangerous complications incidental to chronic ear disease will be avoided. In children who have had such an attack the early removal of adenoids is imperative.

Chronic Catarrhal Deafness.—If the eustachian tube is closed but no inflammation exists within the middle ear, the air of the middle ear is gradually absorbed by the blood, and retraction of the ear-drum results. The most frequent cause of deafness is a protracted absolute closure of the eustachian tube so that the ear-drum is frequently subjected to such tension, instead of having the normal equal pressure on both sides. Adenoids and chronic catarrhal inflammations of the nose and throat are the chief causes.

Such deafness is apt to develop gradually and may not be recognized for a long time. For this reason, periodic acoustic tests in school children are of great value. Removal of adenoids and other treatment of the nose and throat is indicated in such deafness.

Mastoid Disease.—In all inflammations of the middle ear the mastoid cells probably also participate, as these cells are backward extensions of the middle ear. In the simple catarrhal inflammation of the middle ear already described, drainage of the fluid ordinarily results in subsidence of mastoid involvement. But in neglected cases, such participation of the mastoid cells in the inflammatory process may result in pus formation, producing what is practically an abscess within the bone behind the ear. Such an infection is obstinately persistent, rarely healing spontaneously and sometimes causing grave complications such as meningitis or brain abscess due to an extension of the inflammatory process into the brain. Surgery is the only effectual treatment, the bone behind the ear being opened so as to drain the pus to the surface. This operation has saved many lives and, if performed before the middle ear has been seriously injured, the hearing remains intact.

Complications of Mastoiditis.—The complications that have their beginning in mastoid disease are extremely serious. They represent extension of the inflammatory process along various routes within the skull. They include: (1) infection of a large vein within the skull which passes close to the mastoid cells, between the skull and the brain; (2) meningitis; and (3) abscesses either on the surface of or within the brain. Some of these conditions are operable and occasionally the patient may recover from them, but operation upon the mastoid sufficiently early to prevent such complications is the safest course.

DISEASES OF THE INTERNAL EAR

Otosclerosis.—This is a rather frequent and particularly intractable form of deafness, in most instances developing in late childhood. It results from an abnormal and excessive growth of the bone about the structures of the internal ear which occurs at the termination of physical development. This abnormality seems to have a familial tendency and is more frequent in girls than in boys. Its cause is under investigation but is still unknown. Prevention and treatment of the condition remain unsatisfactory.

Affections of the Semicircular Canals.—The semicircular canals constitute the organ which controls the sense of equilibrium. Normally, it is possible to stand erect without swaying, even with the eyes closed, and to balance the body during motion, as on a pitching, rolling ship, because the function of the semicircular canals regulates the position and gives warning if one is about to fall. If the semicircular canals are diseased, there is a sense of dizziness, called *vertigo,* and walking or even standing becomes impossible. In a variety of conditions such dizziness may be transitory either with or entirely without disorder of hearing. Certain drugs produce dizziness and faintness; indigestion or seasickness may have the same result. In these, it has been suggested that there may be a slight disorder of the semicircular canals. In certain rare cases in which extreme dizziness has persisted, organic disease of the semicircular canals has been found at autopsy.

Ringing Ears.—Ringing in the ears is a frequent phenomenon. If unusually loud, it is both disagreeable and annoying. It may be caused by certain drugs, notably quinine and compounds of salicylic acid. It occurs in anæmia and in other less definite abnormal conditions of the blood, as well as in disease of the ear, but in many cases its cause cannot be traced. An oversensitive nervous system is predisposed to it. Treatment lies in removal of the cause, if it can be found and is removable. The symptom is of no consequence save for its annoyance, and a determined effort should therefore be made not to permit it to command undue attention.

Deafness in General.—Deafness may result from the diseases of the ear which have been described, ranging from wax in the external canal, and disorders of the middle ear, to those of the internal ear and auditory nerve. Examination determines the cause, or at least the part of the auditory apparatus affected. Some causes are remediable; in others treatment accomplishes nothing.

In permanent deafness certain mechanical aids to hearing are of value.

Systematic training in lip reading is frequently of great assistance, and it deserves mention that in cases of gradually advancing deafness, lip reading is much more easily learned if it is studied while some power of hearing still remains.

Deaf-mutes, or deaf-and-dumb persons, are those who have lost their acoustic sense in infancy, through any cause, and have therefore never learned to speak. By modern methods of training, considerable success has been attained in developing the power of speech in deaf-mutes, and by such means combined with lip reading conversation becomes possible.

CHAPTER XL

DISEASES OF THE EYE

Vision is perhaps the most important source of our perceptions; it is more essential than hearing, as is illustrated by the fact that blindness is a greater handicap than deafness. Not only is blindness a great catastrophe, but a morbid fear of blindness is unfortunately prevalent. Moreover, aside from total loss of vision, less serious visual deficiencies or defects are frequent. Sometimes, such disturbance of vision is discovered after it has existed for years. Never having known any better vision, there is no consciousness of this handicap although it may have seriously impaired success in life. Visual tests in school children have done much to prevent the occurrence of such cases.

Headaches are sometimes a result of imperfect vision and of the excessive effort involved in following studies or other work with defective eyes. On the other hand, the effects of minor abnormalities of the eyes are much exaggerated in the popular mind. Persons predisposed to apprehension in matters of health often direct undue attention to vision. Slight changes of glasses are frequently obtained for minor disorders such as headaches, neuralgias, pains or irritability of the conjunctiva, sensitiveness to light, and spasms of the eyelids, under the impression that these are due to visual abnormalities. As a matter of fact they are largely the result of other causes, particularly to hypersensitiveness of the nervous system and excessive solicitude.

All eyes undergo changes with advancing age. In childhood the lens is flexible and readily focussed for any distance. In middle age, however, it gradually becomes more rigid and less adaptable to its purposes; the result is that close vision, particularly in reading, is usually blurred, while distant vision remains clear. This difficulty is easily overcome by proper reading glasses with slightly convex lenses.

Farsightedness and *nearsightedness* with consequent difficulty in focusing upon near or distant objects respectively, may occur even in youth. Such visual disturbances are due to abnormalities in the shape of the lens. In young people, minor degrees of these disorders may be overcome by increased effort in focusing, but in older persons there is diminished power of adjustment and it cannot be accomplished. In children these abnormalities have various effects. Inattention to objects of interest which should be seen clearly is frequent, and may be primarily due to poor vision, the habit of inattention being a result. In other children, the excessive effort involved in focusing is reflected in the facial muscles, causing scowling and habitual tense expressions, and perhaps nervousness and fatigue. The abnormality of the lens may be compensated by the use of convex or concave spherical glasses, according to the particular needs.

Astigmatism is an abnormality of the lens by which its normal spherical curves vary in different diameters—like the curves of the surface of an egg in contrast with those of a perfect sphere. The result is that objects appear distorted or with blurring in certain planes. Special skill is required to determine the form and degree of astigmatism, and the lenses necessary for its thorough correction. A large part of the work of the ophthalmologist consists of rectifying such aberrations. But these conditions constitute a particular and relatively minor branch of visual disorders. For the eye is an extremely complicated structure composed of many separate parts, each of which is subject to disease and injury.

DISEASES OF THE EYELIDS

Wounds.—Wounds of the eyelids are not uncommon. If the edge is severed, it requires very careful sewing to avoid a permanent notch, but otherwise the treatment is similar to that of other cuts.

Stye.—A stye is practically a boil of the lid margin but, as there is a possibility of communicating the infection to other structures of the eye, it is advisable to use eyewashes in addition to the treatment indicated for boils.

Blepharitis.—In children scaliness of the lid margins known as blepharitis is frequent, and requires careful treatment as severe cases may result in a retraction of the lid margin so that the lashes rub against the eyeball.

DISEASES OF THE CONJUNCTIVA AND TEAR DUCT

The inner surfaces of the lids and the front of the eyeball, save for its central portion, are covered by a smooth membrane known as the conjunctiva. This is kept constantly wet by the tears which may be considered as a natural eyewash. These are secreted from a gland near the outer corner or *canthus* of the eye, and drained through a tube at its inner canthus leading into the cavity of the nose. Occasionally, bacterial infection in this tube may produce inflammation, sometimes with abscess formation.

The *conjunctiva,* which may be referred to for convenience as the covering of the whites of the eyes, is subject to inflammations, some mild and insignificant, others very serious. The conjunctiva may become irritated and very pinkish even without infection, from sunburn, windburn, or exposure to dust and smoke. It may also participate in the hay fever reaction.[1]

Catarrhal Conjunctivitis.—The condition of redness and running of the eyes, most frequently seen in connection with coryza, is a mild bacterial infection. Various bacteria produce similar symptoms. One form, known as "pink-eye," is extremely contagious, particularly in children's hospitals and schools, probably transmissible by fingers, handkerchiefs, towels, and other chains of contact. These disorders recover quickly and have relatively insignificant effects.

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[1] See section on Hay Fever in chapter entitled Diseases of the Nose and Throat, p. 444.

Purulent or Suppurative Conjunctivitis.—This infection, on the other hand, is an extremely serious condition, with imminent danger of blindness. By far the commonest variety is that due to the gonococcus. The bacteria are transferred to the eye by the fingers or otherwise, inducing an intense inflammation and discharging pus constantly. The *cornea* or covering of the central portion of the eye may become ulcerated and, if perforation of this thin structure occurs, sight of the eye is usually lost. Extremely careful treatment is necessary, preferably in a hospital. If one eye only is affected, strict precautions are essential to prevent infection of the other.

The same disease in newborn infants is the most frequent cause of infantile blindness. The child's eyes become infected during birth by bacteria in the genital passage of the mother. While in the past many cases of blindness have occurred in this way, the modern practice of placing certain antiseptic drops in the eyes of all infants immediately after birth is an effectual preventive.

Trachoma or Granular Conjunctivitis.—Trachoma is an extremely serious chronic disease of the conjunctiva. It has long been prevalent in certain parts of the world, notably in Egypt where many soldiers in Napoleon's army acquired it. It exists extensively in certain parts of the United States, particularly in southern Illinois and Kentucky, and constitutes a menace which the public health departments are combating. The disease causes redness, painful inflammation, and granular growths within the lids, which have the appearance of boiled sago. As the disease continues, scar formation may produce an opaque layer covering the pupil, with resultant loss of sight. Treatment does much to check the disease in individual instances, but the important problem not yet solved is the control of its cause.

DISEASES OF THE CORNEA

The cornea is a transparent and almost invisible structure, much like the crystal of a watch, which covers the pupil and the colored portion of the eye known as the iris. Its outer aspect is kept moist by the tears; its inner aspect encloses the transparent watery fluid of the interior of the eye. It is subject to two types of disturbance, either of which may impair or destroy the eyesight. Any minor injury which produces the slightest damage to the cornea eventually results in a scar which is not transparent. Even a tiny scratch, in its central part, may cause a white patch to appear over the pupil which interferes with vision. The cornea may also be penetrated, with consequent escape of the fluid which it should retain. This may lead to gluing of the structures behind it, with permanent impairment of vision. If, in addition, infection enters, the results are still more serious, even involving destruction of the eyeball.

It is usual for foreign bodies such as specks of dust to lodge on the cornea or on the conjunctiva, and surprisingly small particles may cause much irritation. Those which are too small to be readily visible are more easily discovered by means of oblique illumination with a flash-light. If not firmly imbedded, they may be wiped away with a bit of cotton on a match stick. If, however, they do not come away easily, a physician should be consulted, as unskillful attempts to remove them may produce harmful results as well as unnecessary pain.

Ulceration of the cornea in connection with purulent conjunctivitis has been mentioned. Numerous other forms of ulcer of the cornea exist requiring different methods of treatment.

Phlyctenular Disease of the Cornea.—Children and adolescents, especially those whose general health and nutrition are below par, are sometimes affected by periodical attacks of painful inflammation of the cornea and of the conjunctiva, which usually last for a few weeks but may be recurrent. Grainlike points appear forming small ulcers with inflammation about them. They seldom perforate but may produce scars of the cornea which impair vision. Local treatment of the eyes is of considerable importance, but general hygienic measures are a large factor in controlling the disorder. Although the disease is not a tuberculosis of the eyes, there is a strong suspicion that the eye condition is an effect of tuberculosis in some part of the body. In many cases the general treatment for tuberculosis is of value in effecting improvement and final subsidence.

Interstitial Keratitis.—This is an extremely painful inflammation involving the cornea. It usually occurs in children between the ages of five and fifteen, and runs a course of several months. It is probable that inherited syphilis is a common, if not the only fundamental causative factor. During its course there are symptoms of inflammation as well as haziness of the cornea, which ultimately clears to an extent but some permanent impairment of vision is usual. Local treatment is important for comfort as well as to improve the final outcome. In addition, the general treatment for syphilis is advisable although its effect in this condition is apparently much less striking than in other forms of syphilis.

IRITIS, GLAUCOMA, AND CATARACT

Iritis.—The iris is the blue or brown part of the eye which surrounds the pupil. Iritis is inflammation of the iris, which frequently also involves a structure behind its outer margin known as the *ciliary body.* It causes pain in the eye or in its brow, accompanied by sensitiveness to light, watering of the eye and reduced vision. These symptoms are present in obstinately recurrent attacks, each lasting three to six weeks. There may be serious consequences. Iritis seems to be a local complication of various other diseases. Some cases are associated with infection of the teeth or tonsils or with other distant, local inflammations, and there is frequently improvement when these are controlled. Other cases occur in the presence of tuberculosis, of gout, or of diabetes. It is estimated that twenty-five per cent are accompaniments of syphilis. Local treatment, including the use of drugs to dilate the pupil, is of great importance. Some of the after effects may require operations. Prevention of the attacks lies in the diagnosis and treatment of the underlying primary disease in each particular case.

Glaucoma.—Glaucoma is the chief cause of blindness which develops without warning in adult life. It is usually the one that novelists have in mind when they write of loss of vision. Although all of the factors in its causation are not known, it is a condition in which the watery fluid of the interior of the eyeball is prevented from escaping in its normal flow, so that the globe of the eye becomes distended and hard from abnormally increased internal pressure. There may be certain preliminary symptoms, such as appearance of colored halos around lights, or there may be no warnings. In some instances, the onset is sudden with severe pain in the head and eyes. This attack may subside, with or without treatment, but it is followed by others, and each recurrence causes some increase in the visual defect. In other cases, there are no painful attacks but only a gradual failure of vision, so that often irreparable injury occurs before the condition is recognized. One objective sign of glaucoma is abnormal hardness of the eyeball when pressure is made on it through the upper lid. The opthalmologist obtains further evidence by examining the interior of the eye through the pupil with a special instrument.

Emphasis should be placed upon the fact that without treatment glaucoma must lead to blindness, while immediate operation is likely to prevent further impairment of vision. It is a condition in which prompt and careful attention is of the utmost importance.

Cataract.—Cataract is a clouding or gradually developing opacity of the lens of the eye, which lies immediately behind the pupil. Its most frequent form is that attendant upon old age. The result is a gradually increasing inability to see objects, but power to distinguish between light and darkness is retained; in this respect it differs from total blindness in which there is no perception of light. Cataract is treated by an operation which removes the lens. Subsequently, some vision is possible by the use of a strong glass.

DISEASES OF THE RETINA AND OPTIC NERVE

The retina is a sheetlike structure formed of nerve endings, which is spread out over the posterior part of the interior of the eyeball, serving much the same purpose as the plate in a photographic camera. Somewhat to the inner side of its center, the optic nerve emerges. By means of an instrument known as the ophthalmoscope it is possible to look inside the eye through the pupil, and to see the retina and the end of the optic nerve. Visible changes in the retina involving more or less loss of vision may occur, particularly in chronic nephritis, diabetes, syphilis, and arteriosclerosis. The optic nerve may reveal changes due to inflammation known as optic neuritis. A certain alteration is also evident when pressure within the eye is increased by glaucoma.

Minor inflammations of the optic nerve due to syphilis or nasal sinusitis, or to the excessive use of tobacco or alcohol may recover, but, as a rule, abnormalities of the retina and of the optic nerve are of serious significance, indicating both loss of vision and failure of the general health.

DISORDERS OF THE EYEBALL

Injuries.—The eyeball may be destroyed by heavy blows, by wounds, or other violence, but more frequently by its penetration with a sharp pointed object or a flying fragment. When there is suspicion that something has penetrated the eyeball, it is important to consult an ophthalmologist immediately. Pieces of iron or steel are often removable by means of a large magnet.

Sympathetic Ophthalmia.—An unfortunate and mysterious consequence of some penetrating wounds of the eyeball is that at some time—weeks, months, or even years after the injury—an inflammation may develop in the uninjured eye, leading to its blindness as well. Therefore, to guard against total blindness, any injured eye should receive the best possible care; and in some instances it may be advisable to remove the injured eye, even though it retains some vision, to safeguard the other eye.

Inflammations of the Eyeball.—Infection of the eyeball may occur from wounds, from inflammations penetrating the cornea, or from pyemia.[2] Pus-forming infection soon involves all of the structures within the eye and destroys them. The eye is almost invariably lost, and is usually removed and replaced with a glass eye.

Tumors of the Eye.—There are two forms of sarcoma which originate in the eye and which tend to produce secondary (metastatic) fatal tumors in different parts of the body, particularly in the liver. If the tumor in the eye is recognized before metastases develop, the eye should be removed in the hope that life may be saved.

Squints and Tremors of the Eyeball.—Crossed eyes and squints are frequent. Those appearing in adult life are the result of paralysis of ocular muscles, but the form which is present in children is not related to paralysis. In this latter variety exercises and methods of training are of value, but in pronounced instances operations are often advisable.

Twitching movements of the eyeball are not infrequent and are believed to be unconscious involuntary habits due to poor vision from infancy. Corrective glasses are the chief means of relief.

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[2] See section on Septicemia and Pyemia in chapter entitled Infections, p. 220.

EYE DISORDERS ORIGINATING IN THE NERVOUS SYSTEM

Hysteria [3] and neurasthenia [4] are both frequently manifested by eye symptoms. Hysteria may cause complaint of poor vision in all degrees up to blindness, although nothing abnormal is evident upon examination of structures of the eye. In such cases the visual defect is usually most marked at the margin of the field of vision; in other words, there is difficulty in seeing objects more than a little removed from the point upon which the eye is fixed, or toward the left or right side.[5]

Neurasthenia has many varied ocular symptoms, particularly sensitiveness to bright light and fatigue of the eyes if they are used intently for more than short periods. Associated with the sensitiveness to light there is often excessive winking or spasm of the eyelids. Overattention to the eyes and fear of blindness or of serious disease are often factors. If visual defect requiring glasses is present, glasses should be supplied, and a careful examination should be made to exclude organic disease of the eye; otherwise, the treatment is that of neurasthenia combined with regulation of the use of the eyes.

Many such patients become wedded to colored glasses and to the application of various eye drops. While these aids have their place they are much abused, and should be discouraged as they promote undue solicitude in the care of the eyes.

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[3] See section on Hysteria in chapter entitled Diseases of the Nervous System, p. 375.

[4] See section on Neurasthenia in chapter entitled Diseases of the Nervous System, p. 376.

[5] Similar abnormalities of the field of vision may also occur in certain organic diseases.

ADDENDUM

DEATH, CONSIDERED OBJECTIVELY

Death is very naturally an awesome event, producing a profound emotion of horror in all who observe it. To those who witness it but rarely, the experience is so poignant that its memories become ineradicable, and although in physicians the extreme consciousness of its individual significance diminishes with familiarity, it does not entirely subside. On such occasions the doctor shares the emotions of the patient's family to a greater extent than is generally supposed.

In connection with death, however, it should be mentioned that there are many popular, unjustified misconceptions, some of which tend greatly to exaggerate its sentimental and tragic aspects. Fiction and the drama have largely contributed to these. Grief among relatives and friends is natural and normal, but there is no reason why the emotion should be multiplied by sentimental fancies which belie facts.

Every normal person seeks to avoid death. This is natural; it is furthered by man's fundamental instinct of self-preservation. Fear of death, which may become exaggerated to panic, is bound up in this instinct, and is present in every individual although in greatly varying degrees. But as death is an experience which is universal, there is a decided advantage in facing its meaning with reason, so that understanding may supplant ignorance.

If generalization of human frailties is ever justifiable, it may be considered the prerogative of physicians, particularly with respect to death, as they are familiar with all its austere detail. The dramatic features of death so conspicuously drawn in imaginative writings are seldom present. The earlier symptoms of fatal diseases are much the same as those of severe non-fatal disorders—in fact many of the latter cause much more pain and conscious suffering than do most fatal conditions. A patient's fear of death, which might be expected to cause intense anxiety and mental distress, is rarely evident in the critical and failing stages of disease. Emotional persons sometimes develop a state of panic with the onset of an illness, but, curiously, such an occurrence is more frequent and is quite as intense in non-fatal cases. Generally, throughout the course of a serious illness the patient gives no sign of active apprehension, but on the contrary seems to be chiefly concerned with each present moment. Moreover, there is convincing reason to believe that when death threatens, there is usually a dulling of the sensibilities which almost anæsthetizes conscious suffering. The mental reactions and expressions of patients tend to substantiate this. Moreover, numerous persons who have been on the point of death bear testimony to the fact that they have no memories of extreme suffering in connection with their illness.

The mental state known as *delirium* is frequent in serious illness. This is recognized to be present when patients talk irrationally, imagine things that are not true, and are either abnormally excited or dreamy. In many instances of delirium there is no manifestation of its existence, the patient has not said or done anything definitely abnormal, but after recovery the period is a complete blank. Delirium is very similar to the state of "coming out" of ether, and may possibly produce an effect similar to mild anæsthesia. There is reason to hope that any apparent suffering which occurs in delirium is not of the same degree as conscious suffering; at least it is usually not remembered after recovery.

At the close of life there are considerations other than those concerned with the physical illness actually causing death—cessation of life's activities, its joys, its hopes, its struggles, all its satisfactions and dissatisfactions, provision for dependents, and religious considerations. These, however, bear no discussion here, save to remark that it would seem to be apparent from observation that the mind seldom concerns itself with these matters when physical illness becomes serious. The time for considering them is before its advent, or before the mind has become so affected as to be no longer clear and vigorous.

There is one popular misconception concerning a moment of intense mental clarity bordering on the miraculous just before death. This is based upon the fact that when well persons are faced with accidental death, as by drowning, the momentary excitement incidental to the experience seems to act as an intense stimulant to the mind. Another supporting fact is the custom prevailing in legal procedure of admitting as evidence statements of persons who are conscious that they are about to die, on the assumption that under the circumstances they will speak nothing but the truth. Notwithstanding all this, however, persons whose minds become clouded in the exhaustion of fatal disease have no return of lucidity.

The glaring error of fiction writers in describing death scenes is that their heroes and heroines remain actively aware of the dramatic possibilities of their situation up to the instant of death. Actual death scenes seldom partake of that quality. The impassioned impressive speeches of death scenes portrayed from the imagination are rather such as might be made by a person in excited response to impending death, but only before the ravages of diseases have produced their effects. In most real instances, the last conversations imbued with any memories of satisfaction to relatives are those which occur many hours before death; and after delirium and mental clouding have appeared, no great significance should be attached to any utterances.

A classic example of a courageous and philosophic attitude toward death is that of Socrates in anticipation of his execution, who said:

> Let us reflect . . . and we shall see that there is great reason to hope that death is a good, for one of two things: either death is a state of nothingness and utter unconsciousness, or, as men say, there is a change and migration of the soul from this world to another. Now if you suppose that there is no consciousness, but a sleep like the sleep of him who is undisturbed even by the sight of dreams, death will be an unspeakable gain. For if a person were to select the night in which his sleep was undisturbed even by dreams, and were to compare with this the other days and nights of his life, and then were to tell us how many days and nights he had passed in the course of his life better and more pleasantly than this one, I think that any man, I will not say a private man, but even the great king, will not find many such days or nights, when compared with the others. Now if death is like this, I say that to die, is gain; for eternity is then only a single night.
>
> But if death is the journey to another place, and there, as men say, all the dead are, what good, O my friends and judges, can be greater than this. If indeed when the pilgrim arrives in the world below, he is delivered from the professors of justice in this world, and finds the true judges who are said to give judgment there, Minos and Rhadamanthus and Aeacus and Triptolemus, and other sons of God who were righteous in their own life, that pilgrimage will be worth making. . . . Nay, if this be true, let me die again and again. . . .
>
> Wherefore, O judges, be of good cheer about death, and know this of a truth—that no evil can happen to a good man, either in life or after death. He and his are not neglected by the gods. . . .[1]

And:

> . . . I am quite ready to acknowledge, Simmias and Cebes, that I ought to be grieved at death, if I were not persuaded that I am going to other gods who are wise and good (of this I am as certain as I can be of anything of the sort) and to men departed (though I am not so certain of this), who are better than those whom I leave behind; and therefore I do not grieve as I might have done, for I have good hope that there is yet something remaining for the dead, and, as has been said of old, some far better thing for the good than for the evil."[2]

[1] *Dialogues of Plato,* "The Apology of Socrates," Harvard Classics, II, pp. 27-28.

[2] *Dialogues of Plato,* "Phædo," *ibid.,* p. 51

Beyond this wisdom of more than twenty centuries ago, it is a truth, as any physician will attest even though he may not profess religious convictions on his own part, that many persons facing death are supported in fortitude and calm resignation by faith in Christianity.

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